



**SPARK**  
MUSEUM  
ELECTRICAL INVENTION









Starrett®  
No. 673  
THE L.S. STARRETT CO., ATHOL, MASS.



USE FINISH  
HOLES TO LIFT  
TOOL OFF BASE





























































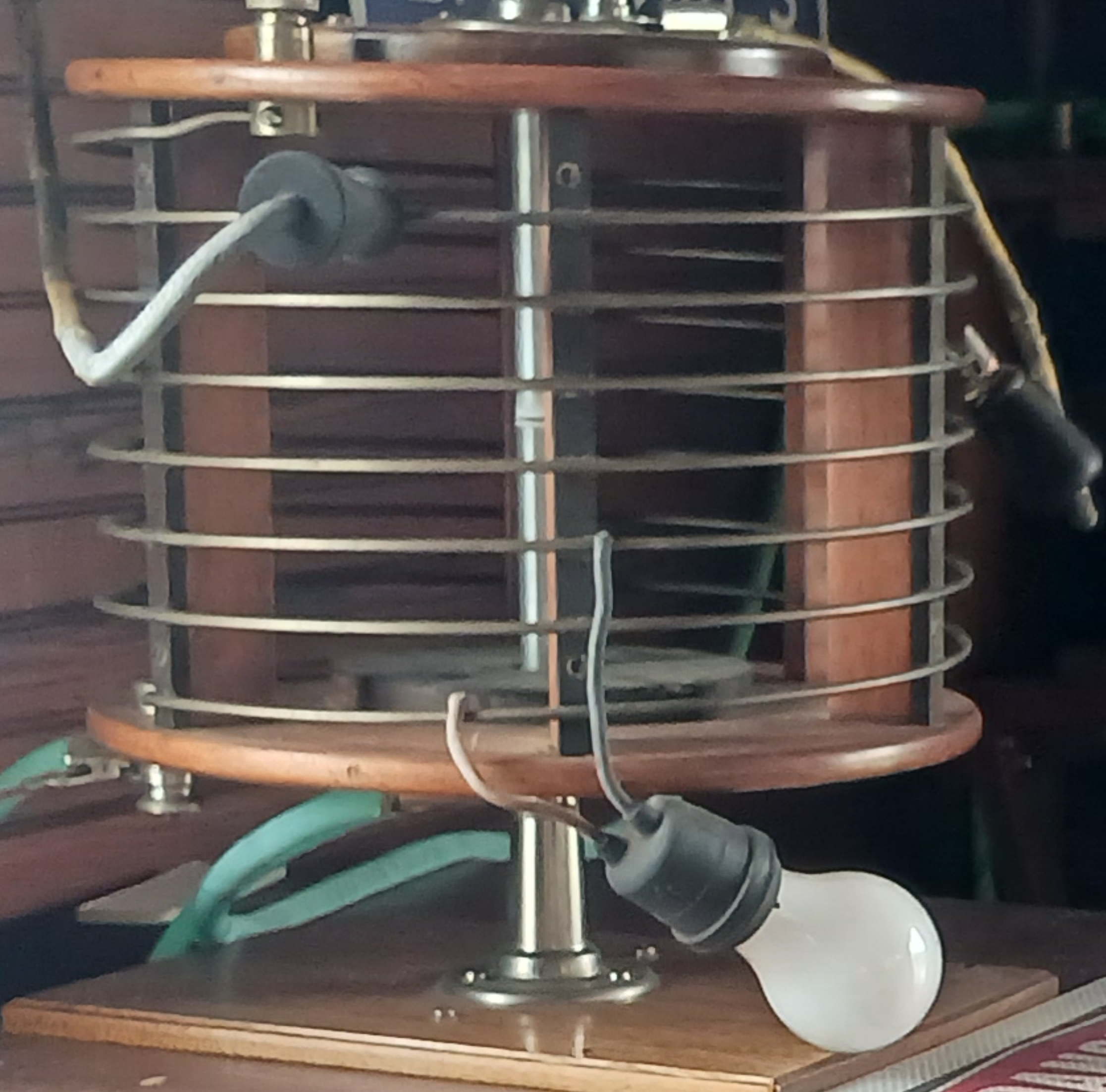


THINK

Welcome "Anyone with the slightest inkling of curiosity"



KEEP OFF  
LIVE WIRES



**KEEP OUT**  
DANGER

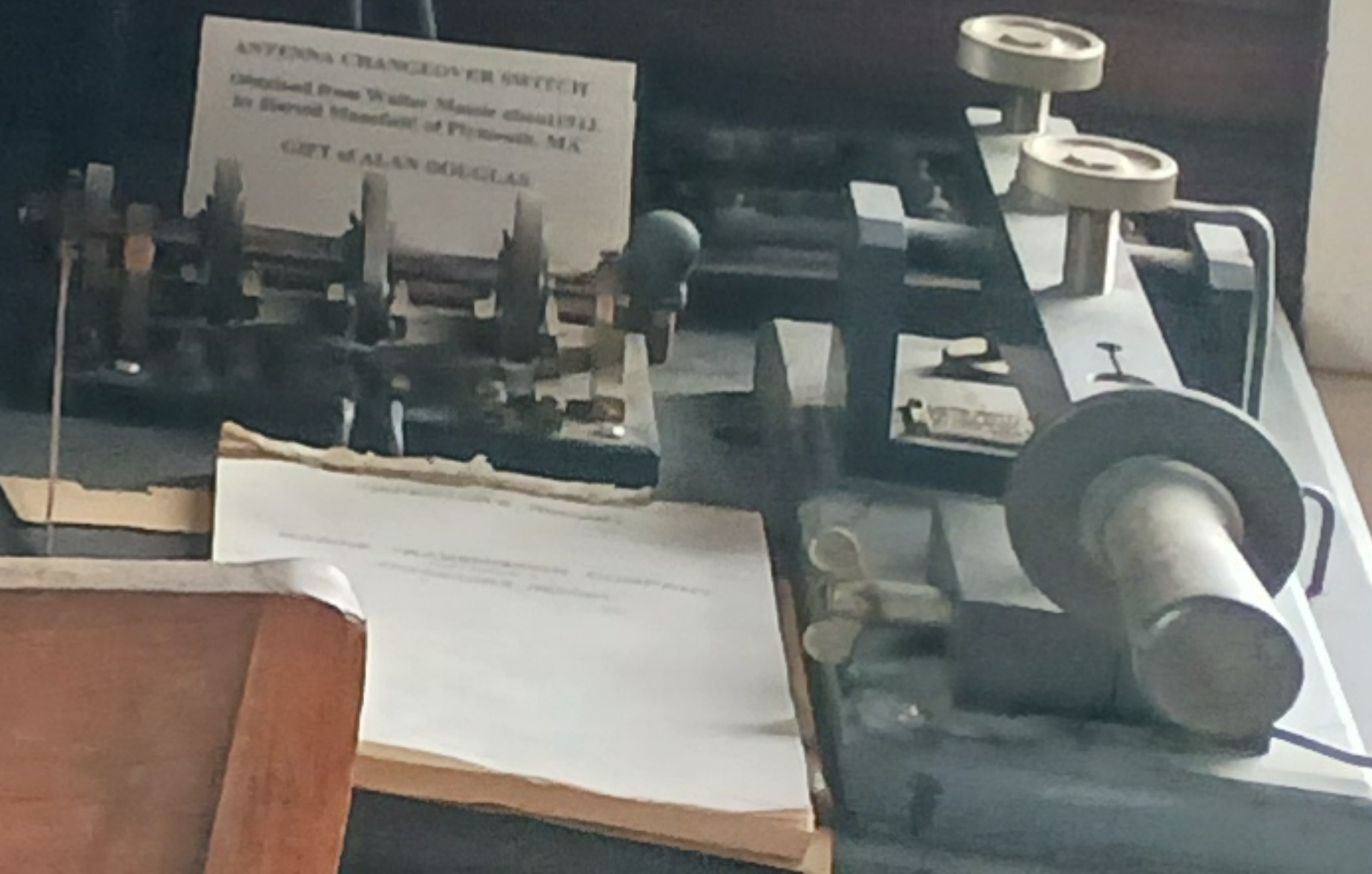
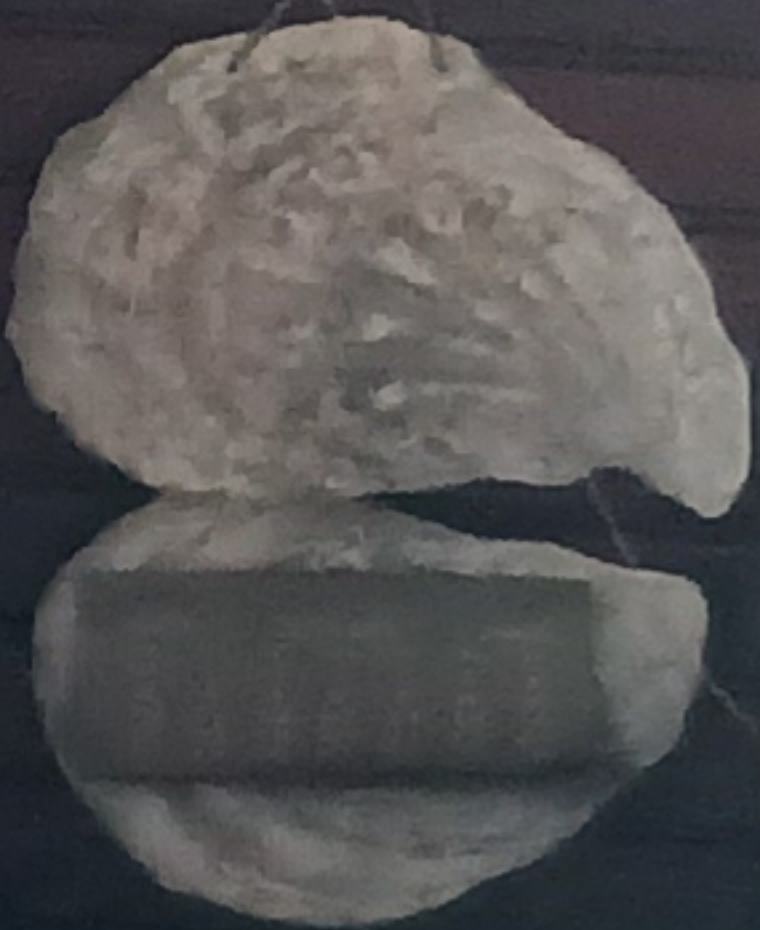
MASSIE WIRELESS TELEGRAPH  
POINT JUDITH, R.I.

MESSAGES ACCEPTED  
FOR TRANSMISSION TO  
**All Sound Steamers**  
Maissie Wireless Telegraph

**PJ**  
MASSIE WIRELESS STATION  
CALL LETTERS "PJ"  
BUILT AT POINT JUDITH, R.I.  
IN 1907  
IT IS THE OLDEST WORKING  
WIRELESS STATION IN THE WORLD  
MOVED TO THIS SITE BY VOLUNTEERS  
IN 1982

**⚠ DANGER**  
 **RADIO  
FREQUENCY  
HAZARD**  
Dangerous to  
pacemakers.

ANTENNA CHANGEOVER SWITCH  
Original from Walter Nelson donated  
by Harold Woodford of Plymouth, MA  
GIFT OF ALAN DOUGLAS

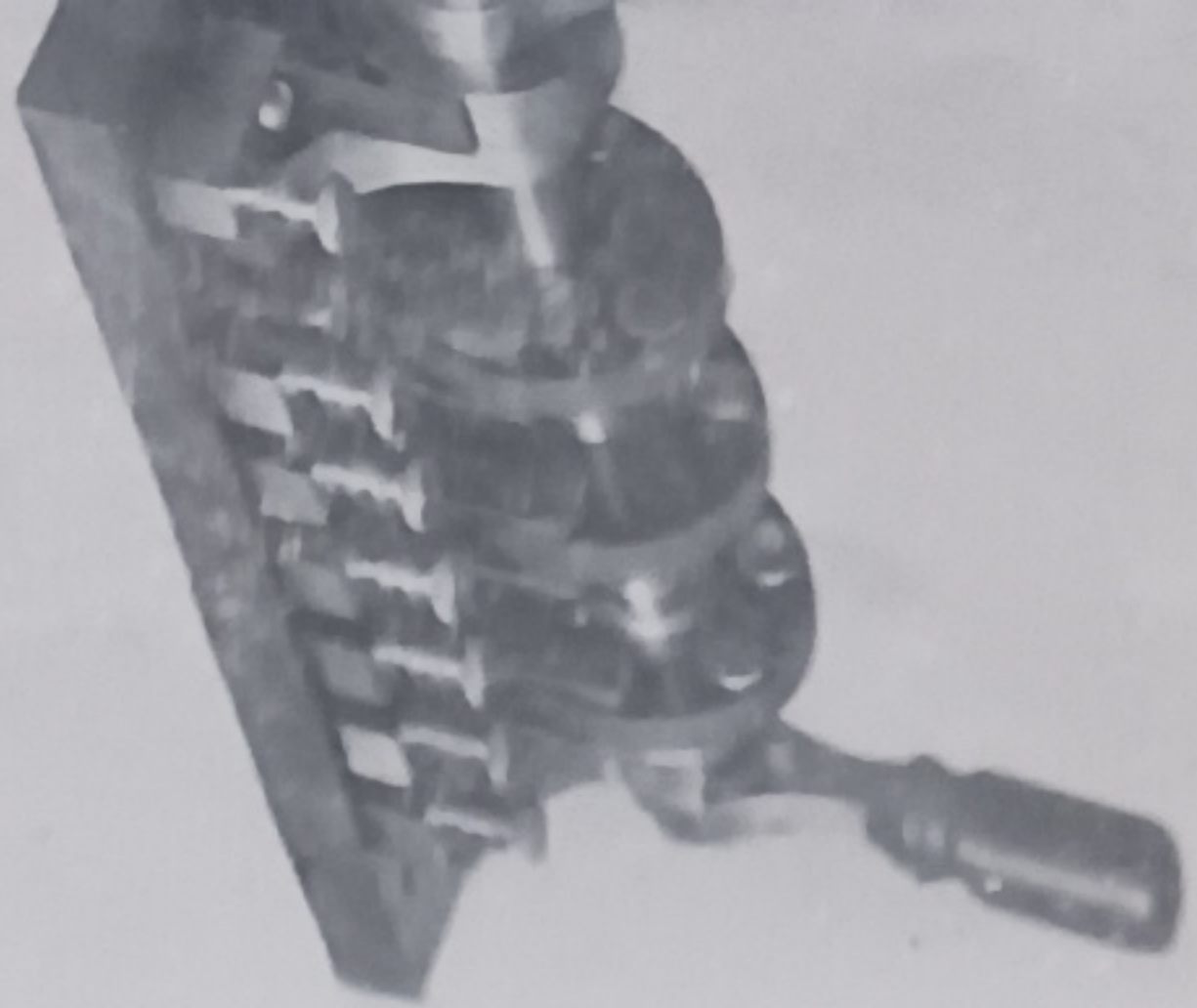




"DAS SENDINGMACHINEN IS NICHT FOR GERFINGER POKEN UND MITTEN-  
GRABEN. IS EASY SCHNAPPEN DER SPRINGENWORK, BLOWENFUSEN, UND  
POPPENCORKEN MIT SPITZENSARKEN. IS NICHT FUR GERWERKEN BY DAS  
DUMMKOPFEN. DAS RUBBERNECKEN SIGHTSEEREN KEEPER DAS HANDS IN  
DAS POKETS. RELAXEN UND WATCH DAS BLINKENLIGHTS."



engineering courses at Tufts College and spent  
courses at Brown University. On leaving college  
he entered the City Engineer's office, where he  
won rapid promotion and performed efficient work  
in important constructions. Since boyhood his  
interests have been spent in making researches and  
studying electrical phenomena. The first practical in-  
vention of his wireless system was at Block Island and  
Boston. He is the son of John G. Massie, a prominent  
city.



LING DEVICE

The Walter W. Massie Radio Sales and Service Bureau  
16 WINDSOR ROAD, EDGEWOOD, R. I.  
TELEPHONE 3004-0907



# Massie Wireless Telegraph Co.



The New England  
Steamship  
Company

The New England  
Steamship  
Company



1916 AMATEUR RADIO HIGH  
POWER SPARK COIL BUILT  
BY LARRY WAGNER, W3AAY

**HAS A SALE**

READY THURSDAY, FRIDAY AND SATURDAY

HUGE SELECTED  
ASSORTMENT OF  
FAMOUS BRAND  
**TOYS**

**49¢**

WE'VE REDUCED TO NEW LOW PRICES  
EVERY STROLLER, EVERY COACH  
LIFT-OFF & FOLDING CARRIAGE IN



19.99



49¢

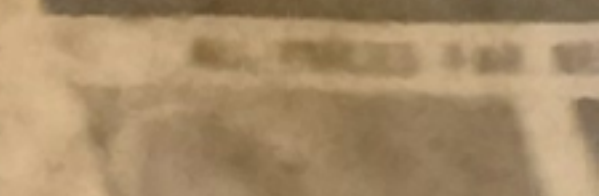


49¢



49¢

EVERY SPORTS  
AS MUCH AS 15%



49¢





WESTON  
WESTON ELECTRICAL INSTRUMENT CO.  
NEWARK, N.J. U.S.A.

WESTON  
WESTON ELECTRICAL INSTRUMENT CO.  
NEWARK, N.J. U.S.A.

WESTON A.C. VOLTMETER  
WESTON ELECTRICAL INSTRUMENT CO.  
NEWARK, N.J. U.S.A.

WESTON A.C. AMMETER  
WESTON ELECTRICAL INSTRUMENT CO.  
NEWARK, N.J. U.S.A.

WESTON  
WESTON ELECTRICAL INSTRUMENT CO.  
NEWARK, N.J. U.S.A.

WESTON  
WESTON ELECTRICAL INSTRUMENT CO.  
NEWARK, N.J. U.S.A.

**DANGER**  
**HIGH VOLTAGE**



KILBOURNE & CLARK  
SEATTLE 1918  
2 KW NAVY STANDARD  
QUENCHED GAP  
SPARK TRANSMITTER  
AND CONTROL PANEL  
*Gift of Arthur and Frances Goshaw*





THIS ALEXANDERSON ALTERNATOR  
POWERED R.C.A. WIRELESS STATION  
KEY BOLINAS, CALIFORNIA  
INSTALLED 1920 - 1947



ARTHUR C. GOODNOW - WIRELESS MAN  
FROM SPARK TO SATELLITE



1988  
This Room Is Dedicated  
To  
**ARTHUR C. GOODNOW, W1DM**  
1908 - 1988  
Former Museum Trustee,  
Chief Transmitter Engineer  
For Westinghouse Group W,  
Eminent Radio Historian And The  
Recognized Authority On Spark Transmitter Design.  
His Career Spanned  
From Spark To Satellite.



TELEFUNKEN QUENCHED GAP  
*Gift of Arthur Goodnow, W1DM*  
ARTHUR C. GOODNOW, W1DM, COLLECTION





The man  
we take for granted



SAVED BY WIRELESS  
Through wireless, the experimenter saved the distressed "Titanic" of 1912. This  
discovery was made by Marconi, the inventor of the wireless. The ship was  
sinking in the Atlantic Ocean, and the crew was in danger. Marconi's  
wireless system was used to send a distress signal to the nearby ship, the  
RMS Carpathia, which arrived and saved the crew and passengers. This  
event proved the value of wireless communication in emergencies.

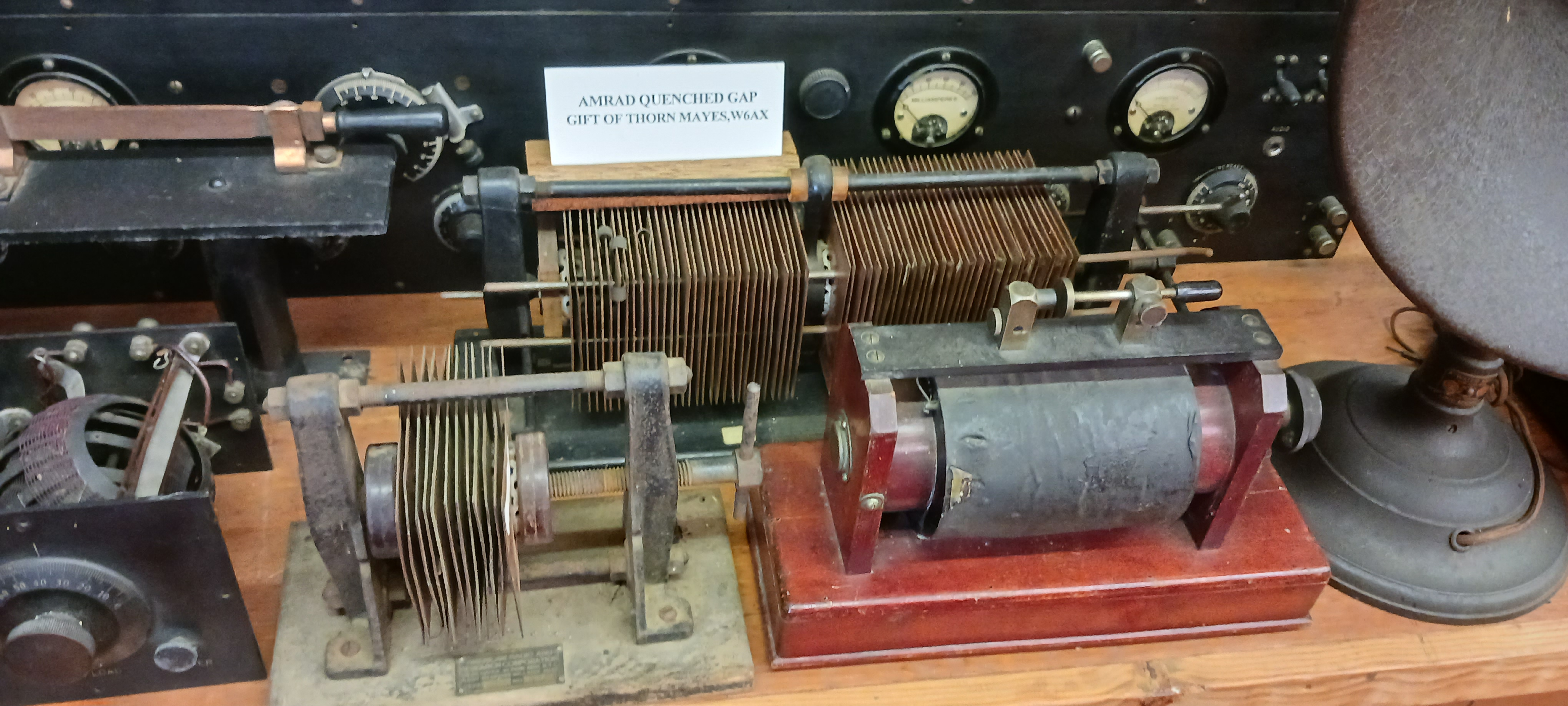
MARCONI WIRELESS  
THE SAME AS  
TITANIC'S TRANSMITTER  
GIFT OF ROLAND H. JENSEN







AMRAD QUENCHED GAP  
GIFT OF THORN MAYES, W6AX





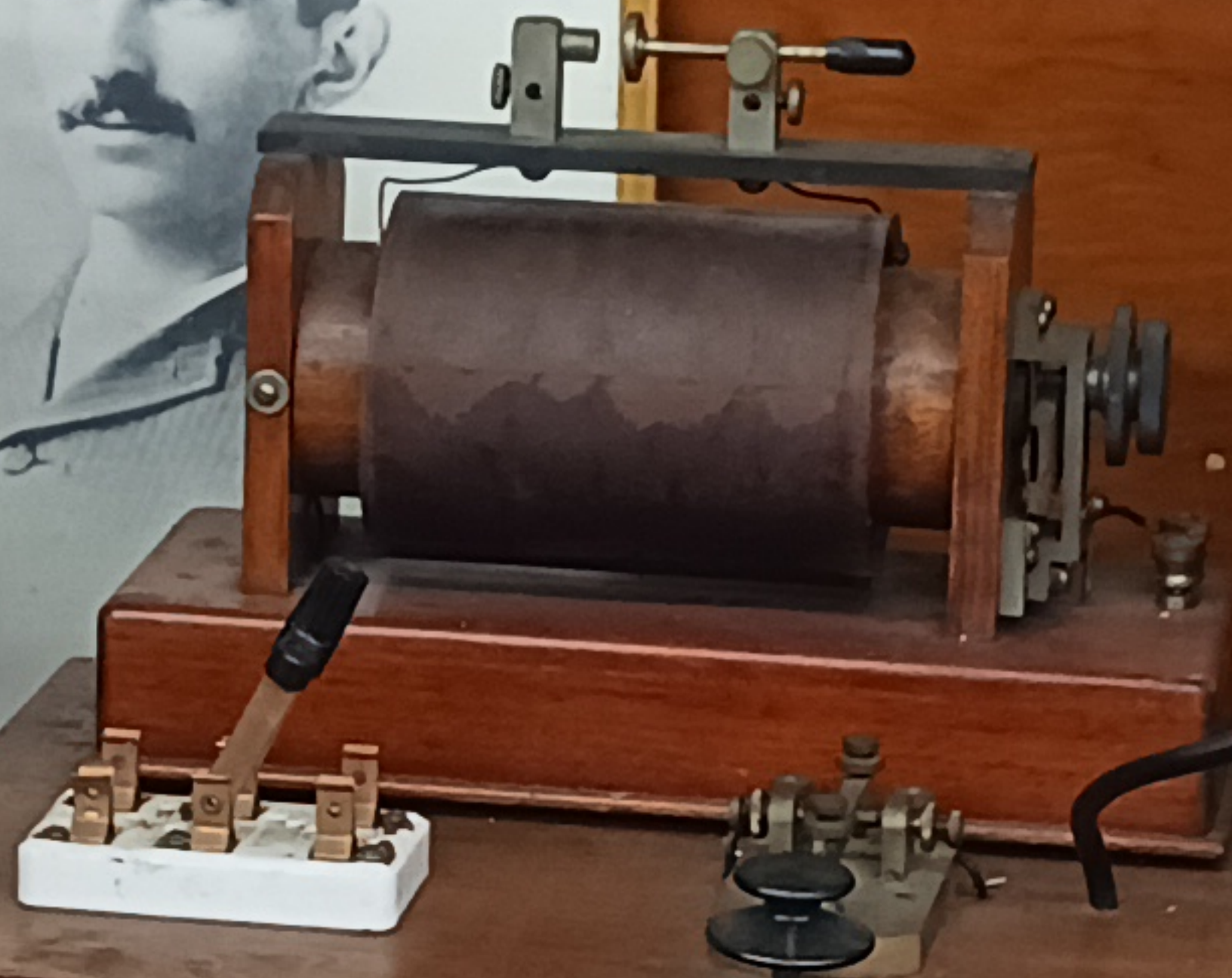




**DANGER**  
**HIGH VOLTAGE**

1KW ROTARY GAP  
SPARK TRANSMITTER  
Built by  
Cdr. Richard Smith  
WINHO

**NOTICE**  
**ELECTRICAL**  
**AREA**



This is the type of wireless transmitter used by amateurs from 1904 to 1910. Before alternating current transmitters became available. The set consists of an ARCAD 2" spark coil, a handwound "rod" type condenser, and a commutator straight on the top of the spark coil. These were often made of aluminum. The earliest gaps consisted of a pair of brass balls. The tuning device is known as a helix. It is a coil of wire wound around a wooden core. It is connected to the one end of the spark coil. The other end of the helix is connected to the other end of the spark coil. The set was originally battery operated, but a step down transformer is used here for convenience. These transmitters were good for 5 to 10 miles. 21 miles was considered excellent.



UNITED STATES OF AMERICA  
**K2TO**



UNITED WIRELESS  
TYPE D TUNER  
GIFT OF  
N. VANCE PHILLIPS  
W6GH



UNITED WIRELESS  
TYPE E TUNER  
GIFT OF  
THORN L. MAYES  
W6AX



# SPARK TRANSMITTERS

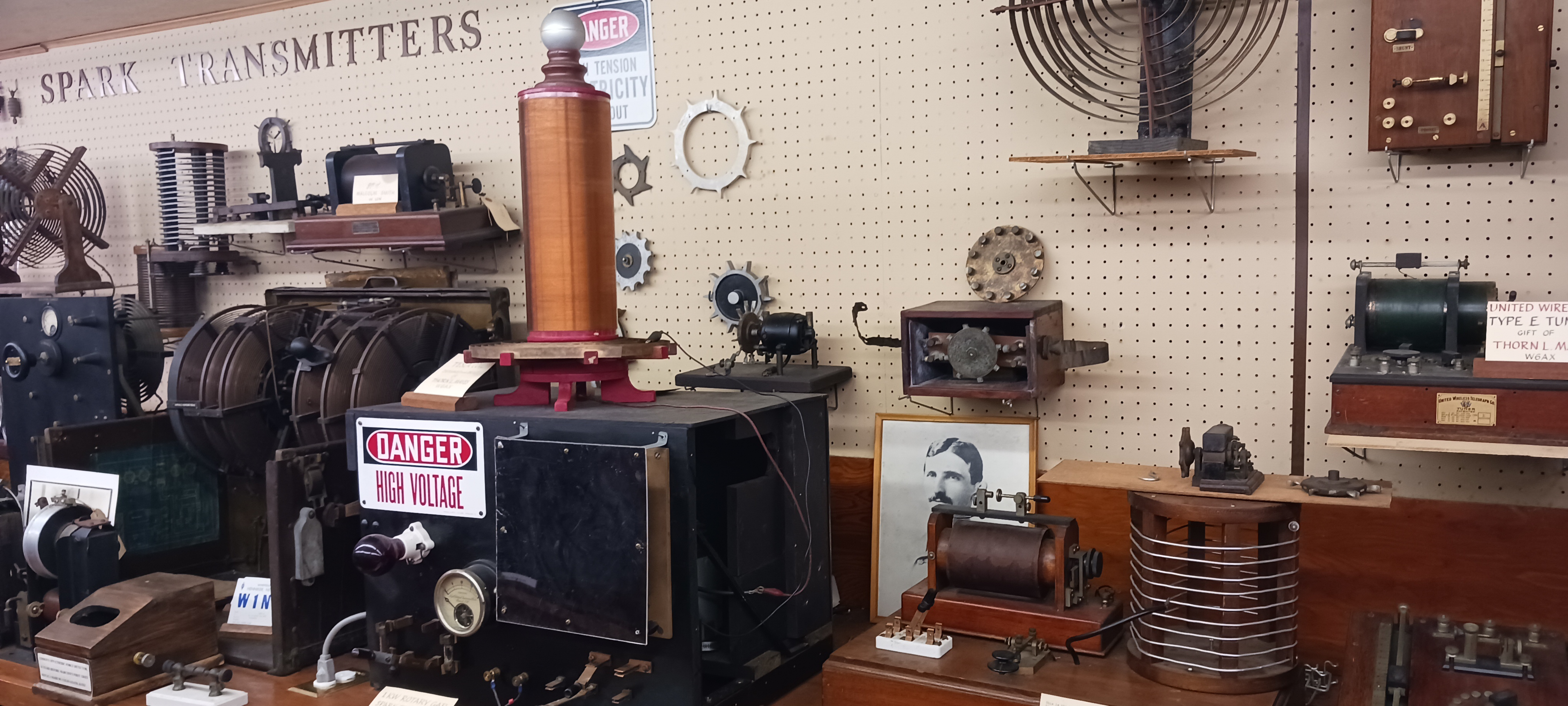
**DANGER**  
HIGH TENSION  
ELECTRICITY  
OUT

**DANGER**  
HIGH VOLTAGE

UNITED WIRELESS  
TYPE E TUNING  
GIFT OF  
THORN L.M.  
W6AX

WIN

LOW ROTARY GAP





ELECTRICITY  
KEEP OUT

Gift of  
MALCOLM SMITH  
EX 10N

SCIENTIFIC EQUIPMENT  
F. J. ROY & SONS, INC.  
BOSTON, MASS.

AUGUSTA  
MAHESST  
1963

TESLA  
DESIGN  
THOR

VARIABLE COUPLING SCALE



HYTONE TRANSMITTER  
NOV 60 500 WATTS  
CLAPP-EASTHAM CO  
CAMBRIDGE MASS  
PATENTED

MAIN LINE  
SWITCH



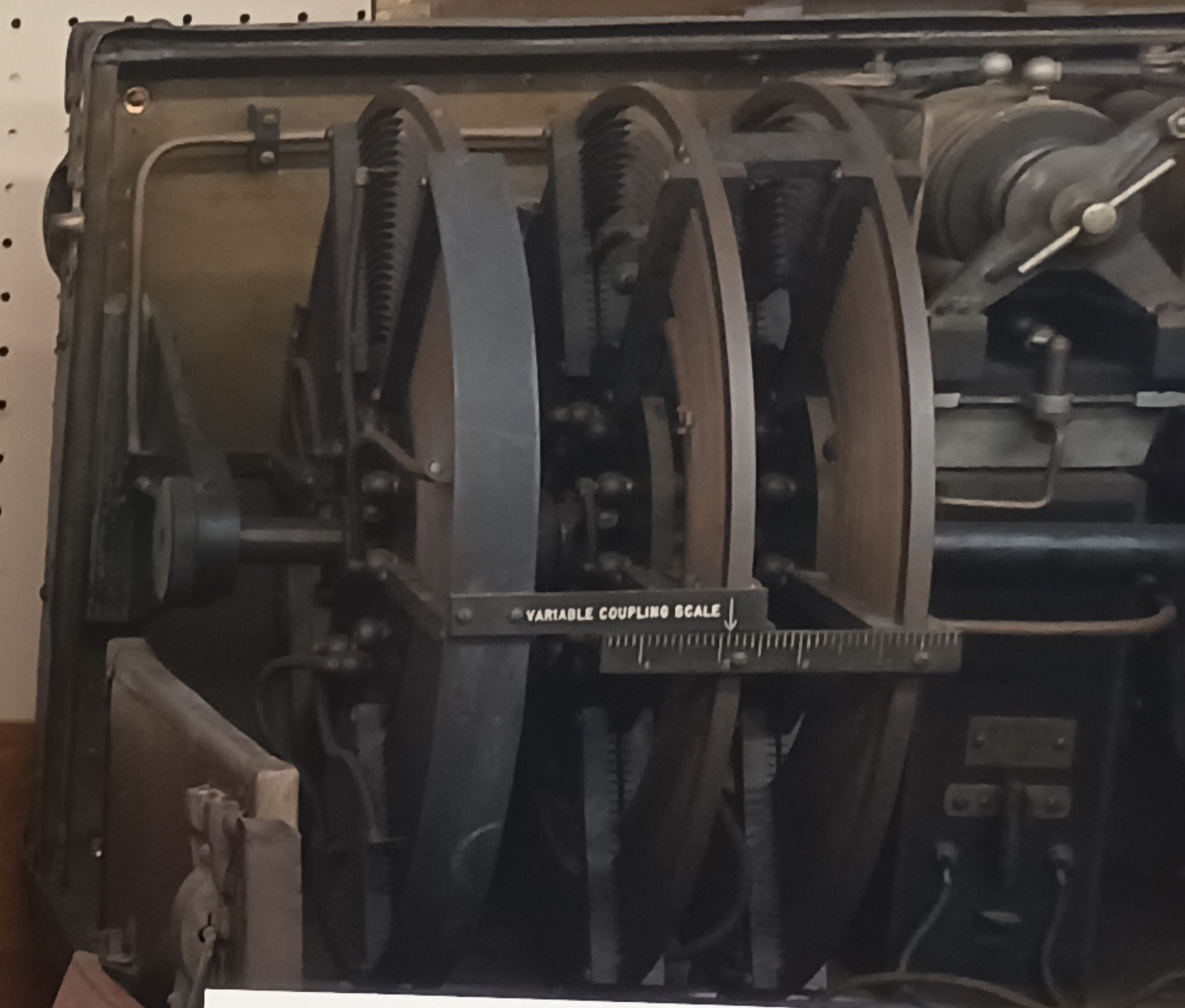
Reconstructed by  
CDR. RICHARD SMITH  
WINHO

RADIO  
1/2 KW  
D C

WHIFFENPOOF FARM  
NEW HAMPSHIRE

EDISON'S 1879 ETHERIC FORCE DETECTOR.  
16 YEARS BEFORE MARCONI'S FIRST TRIES  
REPLICA MADE BY COLIN LEATH, K11XU





the estate of  
CARDWELL

GIFT OF  
JOSEPH J. DE SOUSA, W10FK

Reconstructed by  
CDR. RICHARD SMITH



of the estate of  
N D. CARDWELL



GIFT OF  
EPH J. DE SOUSA, WIOFK

250 Watt Spark Transformer  
Donated by Malcolm  
for 100. 100. 100. 100. 100.





HYTONE TRANSMITTER  
110V 60-500 WATTS  
CLAPP-EASTHAM CO.  
CAMBRIDGE MASS  
PATENTED

MAIN LINE  
SWITCH

LINE

CLAPP - EASTHAM  
1/2 KW BLITZEN  
SPARK RIG ~1910.

GIFT OF  
ERH J. DE SOUSA, W10FK

Reconstructed by  
CDR. RICHARD SMITH  
WINHO

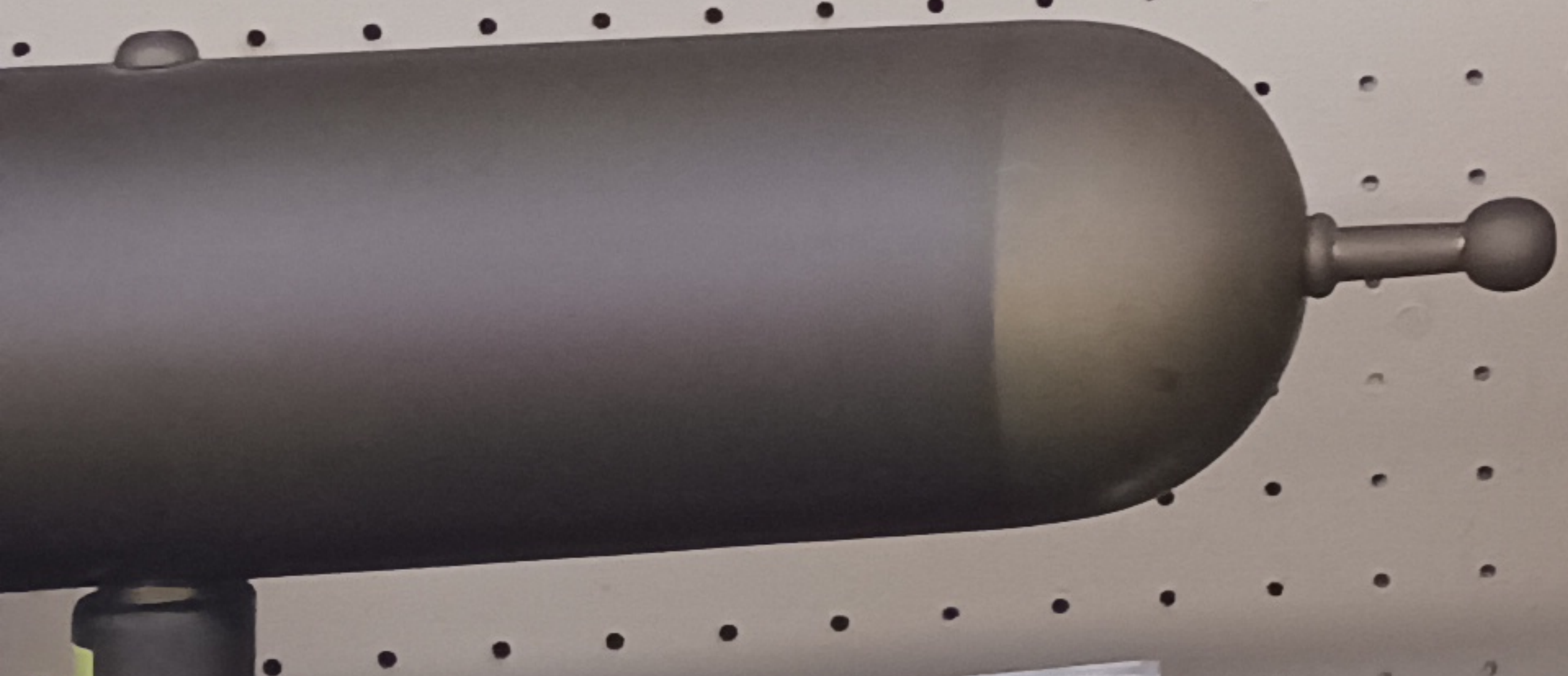
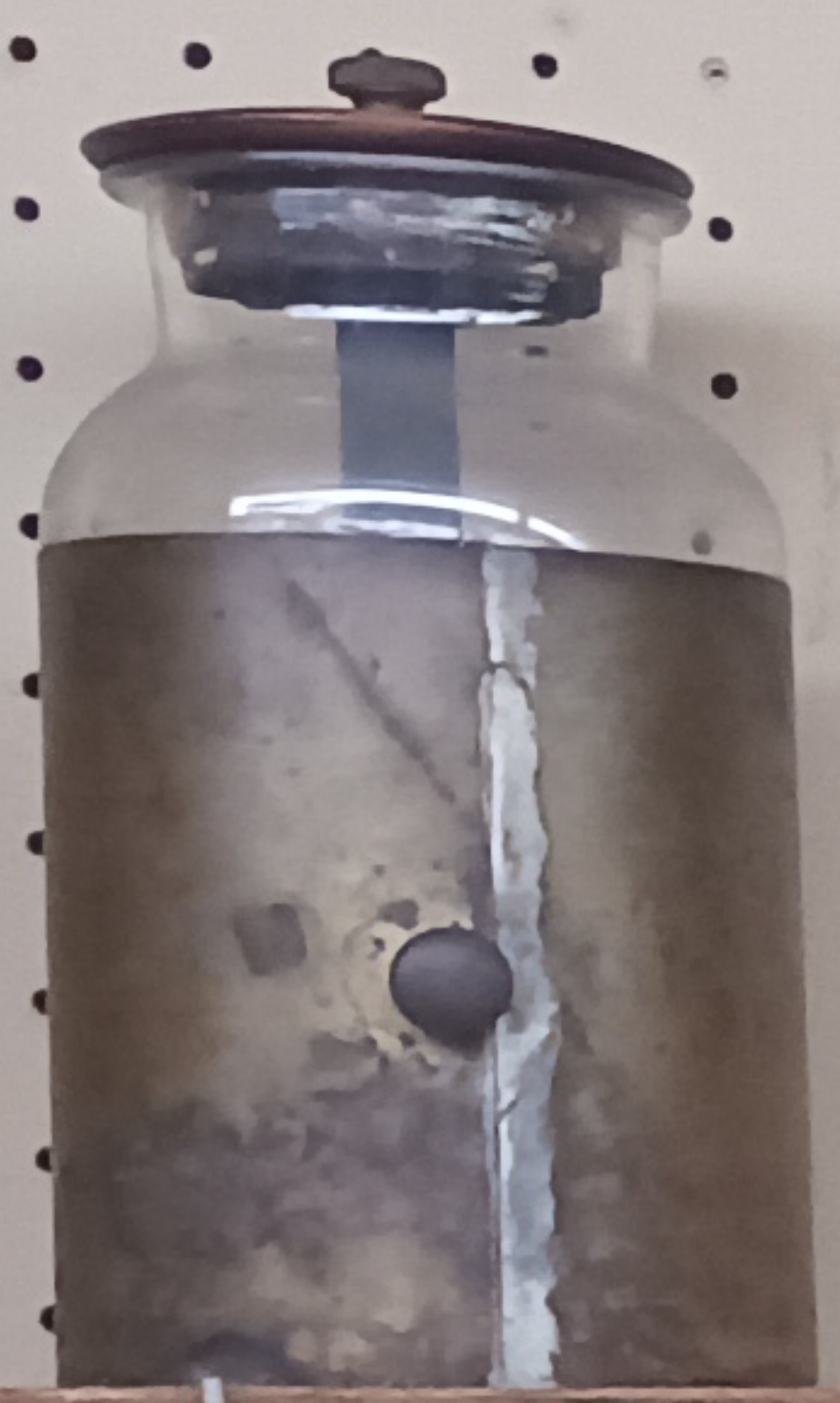


AMIN FRANKLIN  
ELECTRIC BELLS





# BEFORE 1900







*Built by Thora L. Moore  
for his friend, Richard  
H. Kaufmann, and given  
to the museum by him.*

RCA VICTOR'S NIPPER  
GIFT OF  
MILLIE LONGO  
IN MEMORY OF  
BILL LONGO

BENJAMIN FRANKLIN  
ELECTRIC BELLS

BENJAMIN FRANKLIN  
ELECTRIC BELLS

BENJAMIN FRANKLIN  
ELECTRIC BELLS



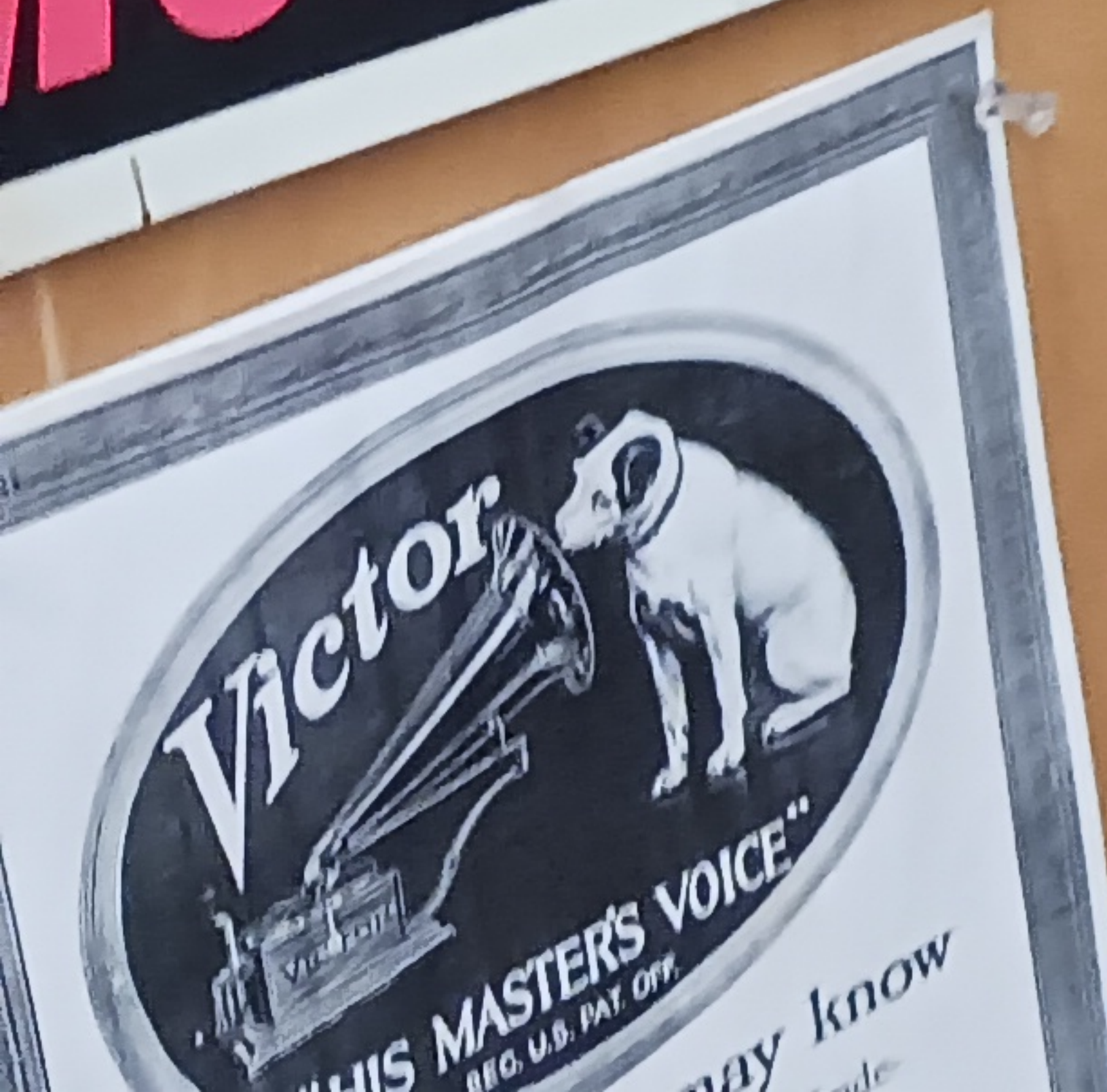


GIFT OF  
AMHERST COLLEGE

BEFORE 1900



A photograph of a 'NO SMOKING' sign. The sign has a black background with the word 'NO' in large, bold, red capital letters at the top, and the word 'SMOKING' in smaller, bold, red capital letters below it. The sign is tilted and pinned to a wooden surface with a silver pin at the top left. A portion of another sign is visible at the bottom right.



by Thorn L. Mayes  
his friend, Richard  
mann, and given  
Museum by him.

RCA VICTOR'S NIPPER  
GIFT OF  
MILLIE LONGO  
IN MEMORIAM





S

**DANGER**  
HIGH TENSION  
ELECTRICITY  
KEEP OUT

COMMERCIAL RECEIVERS

BROADCAST RECEIVERS

**DANGER**  
HIGH VOLTAGE

KENNEDY





**DANGER**  
HIGH TENSION  
ELECTRICITY  
KEEP OUT

COMMERCIAL RECEIVERS

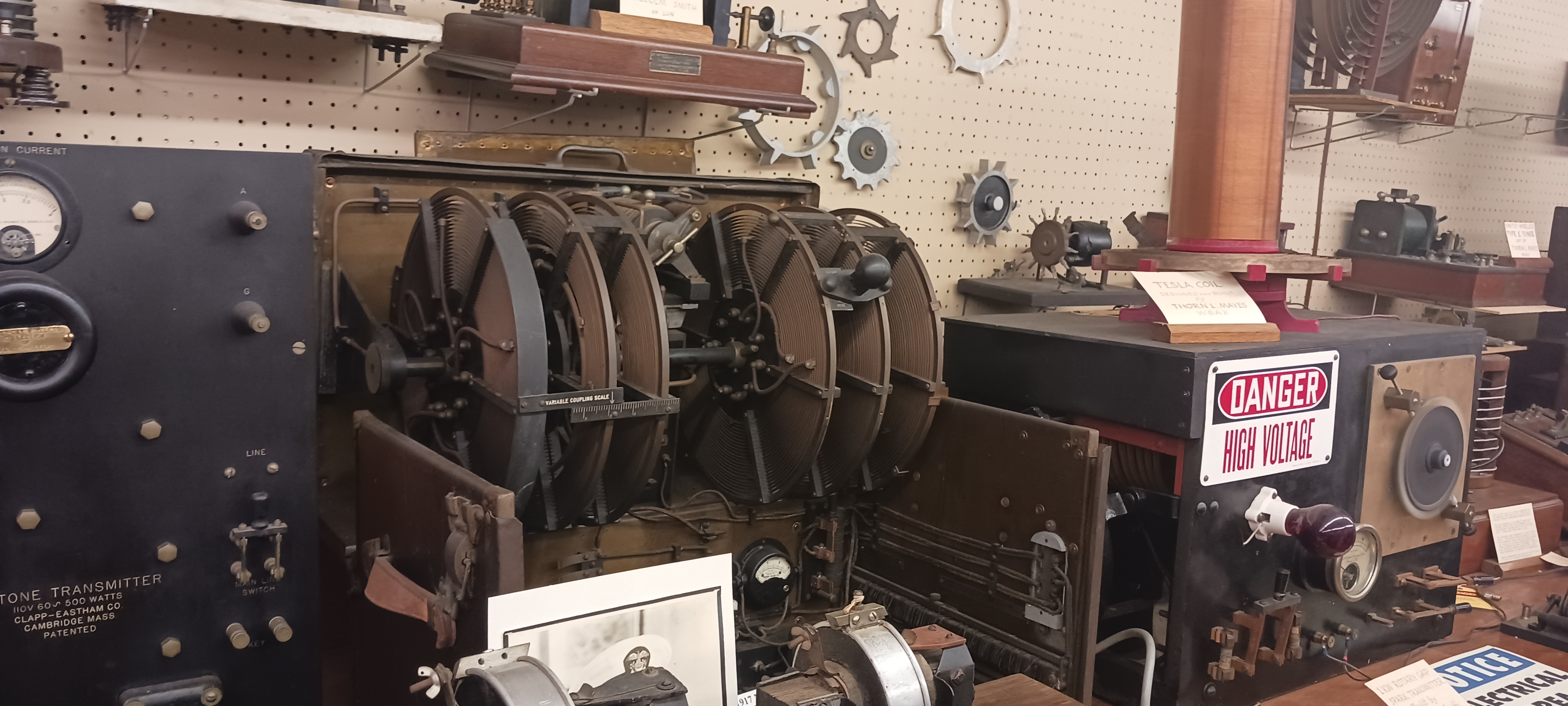
BROADCAST RECEIVERS

**DANGER**  
HIGH VOLTAGE

Donated by  
CIVIL ENGINEER  
H. H. HAY

KENNEDY





N CURRENT

TONE TRANSMITTER  
110V 60 500 WATTS  
CLAPP-EASTHAM CO.  
CAMBRIDGE MASS  
PATENTED

LINE

MAIN LINE  
SWITCH

KEY

VARIABLE COUPLING SCALE

TESLA COIL  
DESIGNED AND BUILT  
BY  
THORNTON L. MAYES  
WBAK

**DANGER**  
HIGH VOLTAGE

NOTICE  
LOW POTENTIAL  
SPARK TRANSMITTER  
BUILT BY





RADIATION CURRENT



HYTONE TRANSMITTER  
110V 60 500 WATTS  
CLAPP-EASTHAM CO.  
CAMBRIDGE MASS.  
PATENTED

LINE

MAIN LINE  
SWITCH

KEY

CLAPP  
EASTHAM  
BOSTON

CLAPP  
EASTHAM  
BOSTON



HYTONE TRANSMITTER  
110V 60 500 WATTS  
CLAPP-EASTHAM CO.  
CAMBRIDGE MASS.  
PATENTED

MAIN LINE  
SWITCH

KEY

GIFT OF  
JOSEPH J. DE SOUSA, W10FK

CLAPP  
1/2 KW  
SPAR

CLAPP  
EASTHAM  
BOSTON

500 Watt Spark Transformer  
Patented Mar 10, 1914  
Clapp Eastham Co.





TELEFUNKEN  
COHERER SET  
1902 - 1905  
GIFT OF  
N. VANCE PHILLIPS  
W6GH

A.W.L.  
UNIVERSAL COIL  
OELLING & HEINZ  
345 NEWINGTON AVE.  
BOSTON, U.S.A.

GIFT OF  
BROWN UNIVERSITY

MARCONI JIGGER OR  
INDUCTANCE COIL C 1900  
400 MICRO HENRIES TAPPE  
GIFT OF ROLAND PETERSON





TELEFUNK  
COHERER S  
1902 - 1905  
GIFT OF  
N. VANCE PHILL  
W6GH

GIFT OF  
BROWN UNIVERSITY

A.W.L.  
UNIVERSAL COIL  
GELLING & HEINZ  
BOSTON, U.S.A.

Pat. ACBL-1035

MARCONI JIGGER O  
INDUCTANCE COIL C  
400 MICRO HENRIES TA  
GIFT OF ROLAND PETER



A. W. L.  
UNIVERSAL COIL  
OELLING & HEINZE  
SOLE MANUFACTURERS  
BOSTON, U. S. A.

GIFT OF  
BROWN UNIVER





A.W. L.  
UNIVERSAL COIL  
OELLING & HEINZE  
SOLE MANUFACTURERS  
BOSTON, U.S.A.

GIFT OF  
BROWN UNIVERSITY

Rm. i AC.P.L-1635

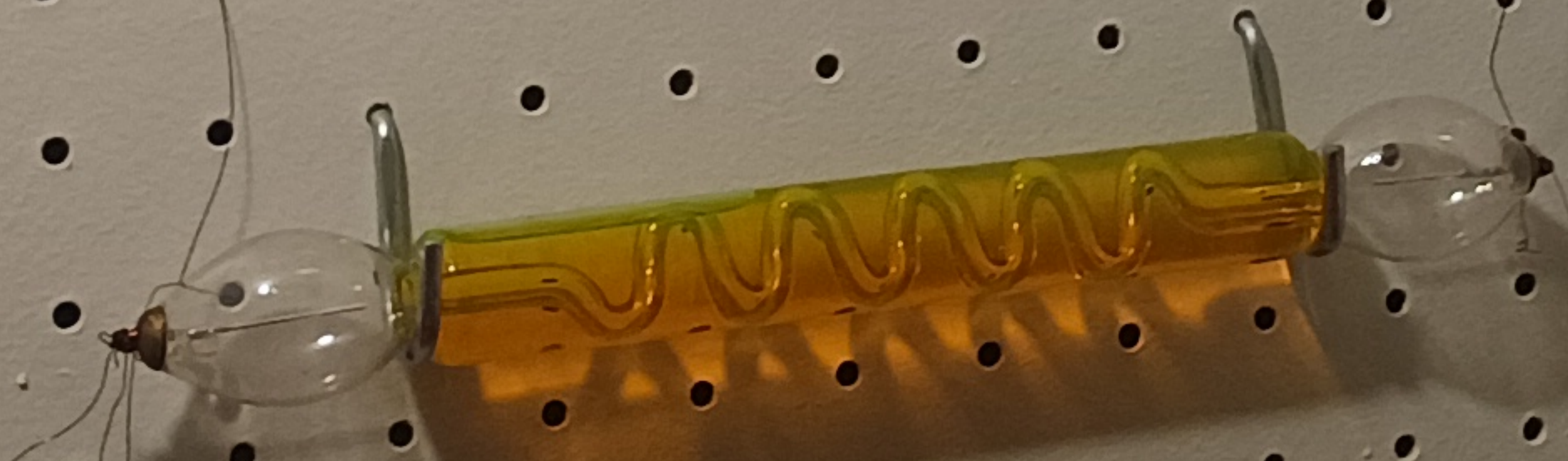
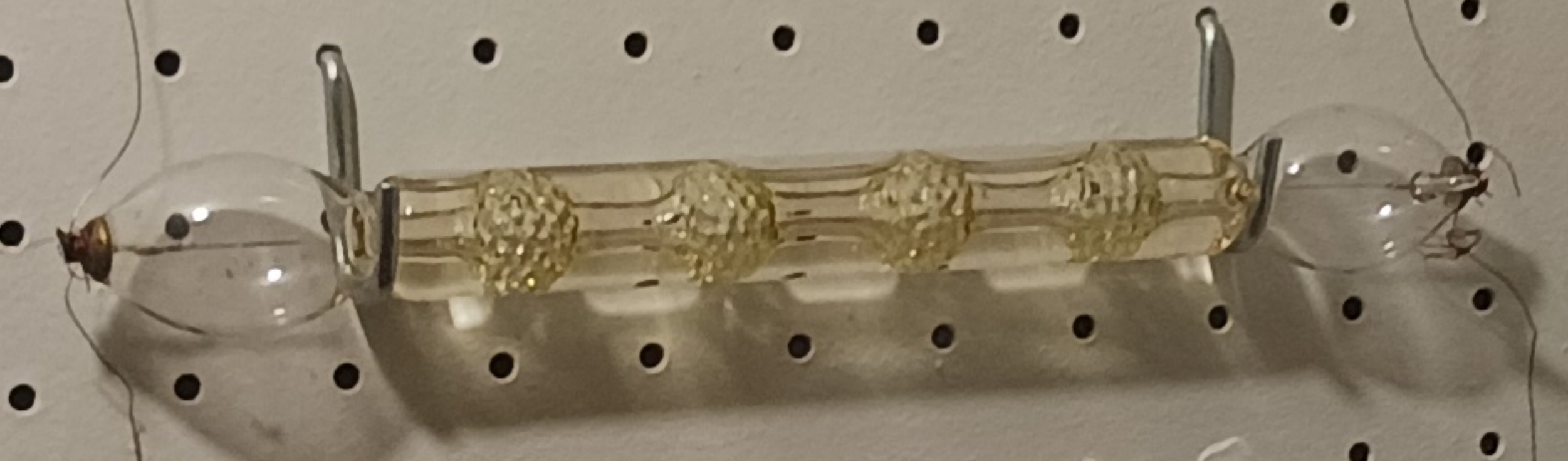
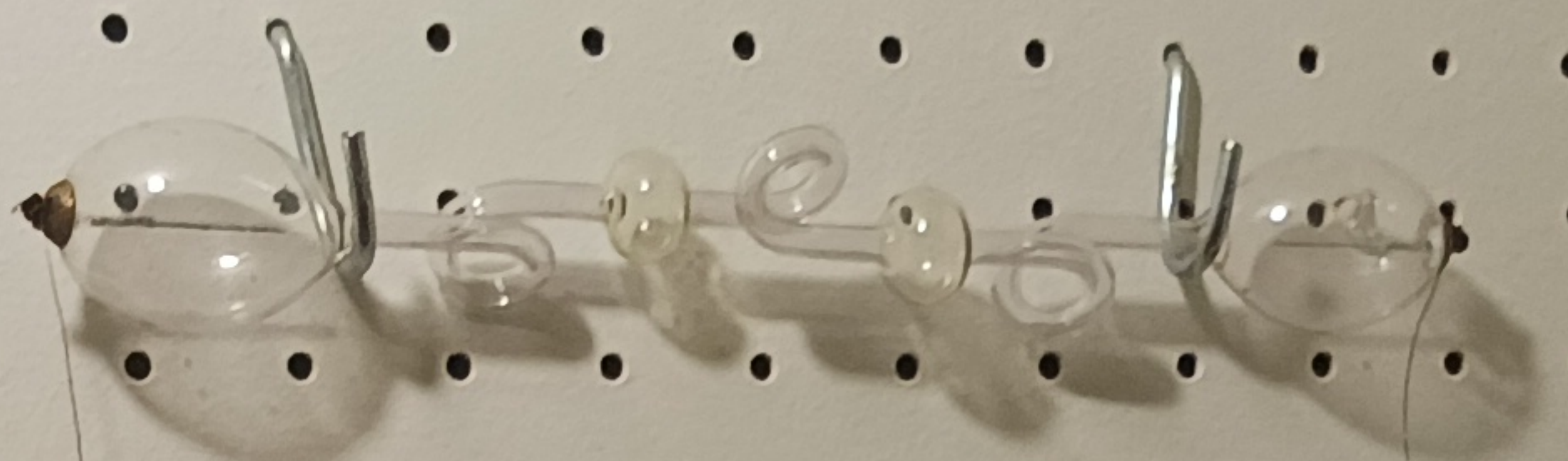
P164


H.C. FAN MOTOR  
H.C. FAN MOTOR  
H.C. FAN MOTOR  
H.C. FAN MOTOR











### RADIO CORPORATION of AMERICA

## RADIOTRON U. V. 201

A NEW AMPLIFIER OF THE PIOTRON TYPE  
FOR  
AMATEUR AND EXPERIMENTAL WIRELESS STATIONS

**C**OMPLEX amplifying circuits for the magnification of radio and  
audio frequency currents require an amplifying Vacuum Tube of  
rigid operating characteristics. There is an increasing demand  
among radio experimenters for a vacuum tube amplifier which will  
magnify the telephone currents in a radio receiving set and which can be  
adapted from one socket to another in a cascade outfit without loss of signal audibility.  
Moreover, the amplifier must be free from the tube "squeals" accompanying the use of im-  
properly designed vacuum tubes.

RADIOTRON U. V. 201, the sound of the new series of Vacuum Tubes designed  
by the engineers of the Research Laboratory of the General Electric Company for the  
Radio Corporation, possesses the qualifications outlined above and it should be a part of  
every experimental radio receiving station. U. V. 201 may be used as a detector, or as a  
low frequency or radio frequency amplifier.

In cascade radio frequency amplifying circuits, U. V. 201 can be adjusted to mag-  
nify without distortion. The use of such circuits is on the increase in amateur stations,  
particularly where long distance communication is desired on short wave lengths (200  
meters or less).

As a detector the best results are secured from Radiotron U. V. 201 with a grid con-  
denser of approximately 1000 mfd. capacity and with a slight GRID LEAK of  $\frac{1}{2}$  to 2  
megohms, according to the type of circuit employed.

The normal plate voltage of Radiotron U. V. 201 is 40 volts, although increasing  
amplification can be obtained at plate voltages up to 100. At 40 volts on the plate, the  
amplification constant varies from 4.5 to 8; at 100 volts on the plate, from 8 to 10. The  
output impedance varies from 15,000 ohms to 25,000 ohms at 40 volts on the plate, and from  
10,000 to 15,000 ohms with 100 volts on the plate.

The normal filament current for RADIOTRON U. V. 201 is approximately 1 amp-  
ere. The filament is designed for connection to the terminals of a 6-volt storage battery  
with a standard filament rheostat in series.

To obtain maximum amplification with U. V. 201 means should be supplied  
for placing negative potentials on the grid, although good amplification may be supplied  
for the use of U. V. 201 in amplification circuits. The requisite negative grid potential  
may be secured by connecting a standard potentiometer, or by placing a 2 ohm resistor in series with the negative terminal of the  
filament and connecting the "wiper" potential terminal with the negative terminal of the  
potentiometer. The latter method usually provides the requisite grid  
potential results, but the proper values for maximum amplification is generally best found  
by trial and experiment, with a variable source of e.m.f. supplied locally.

**IMPORTANT FACTS CONCERNING RADIOTRON U. V. 201**

The Radio Corporation's gas content detector and amplifier tube, RADIOTRON U.  
V. 201, is as well as excellent low frequency amplifier, but it does not give the "power"  
amplification obtainable from the Corporation's SPECIAL AMPLIFIER TUBE RADIO-  
TRON U. V. 201. Thus, for devices requiring a considerable amount of energy for their







THIS MAGNETIC REFLEX  
WAS BUILT BY THOMAS HARRIS  
AND DONATED TO THE MUSEUM  
ALONG WITH THE ABOVE.

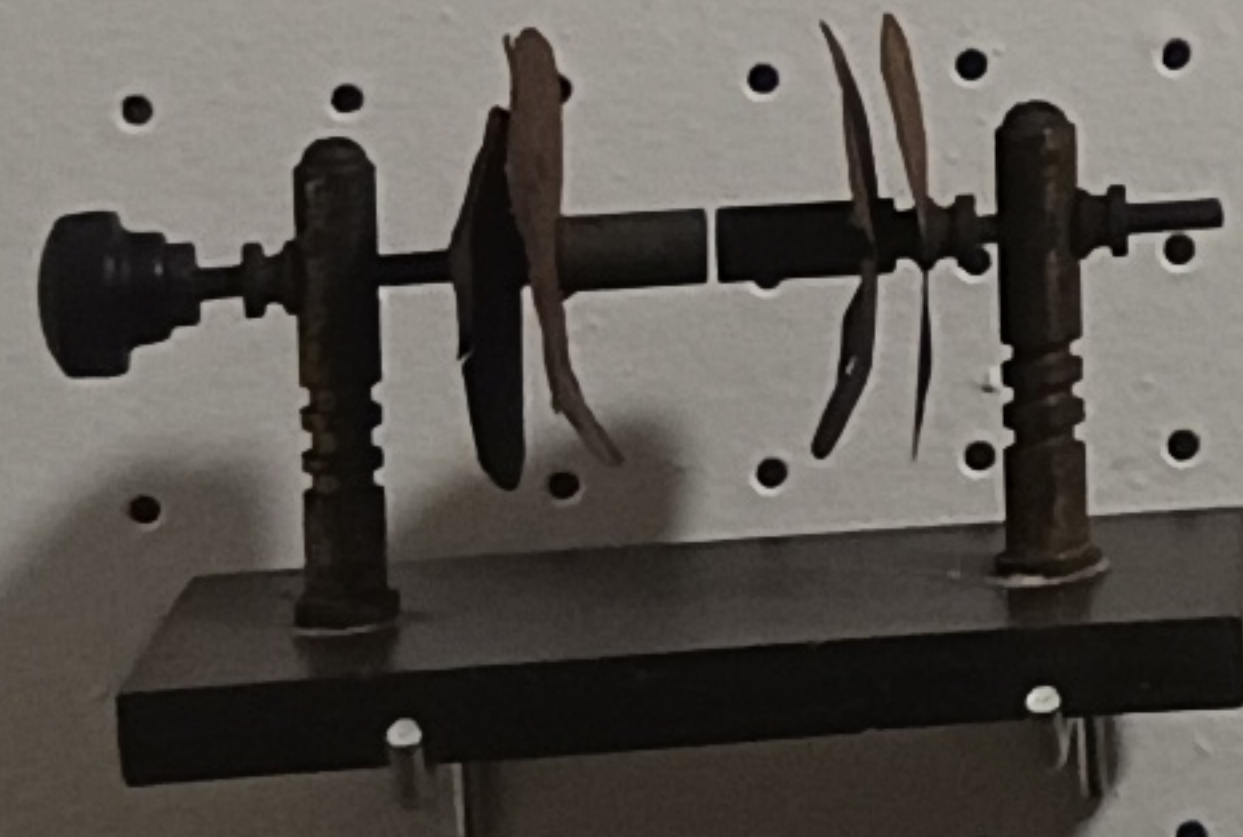
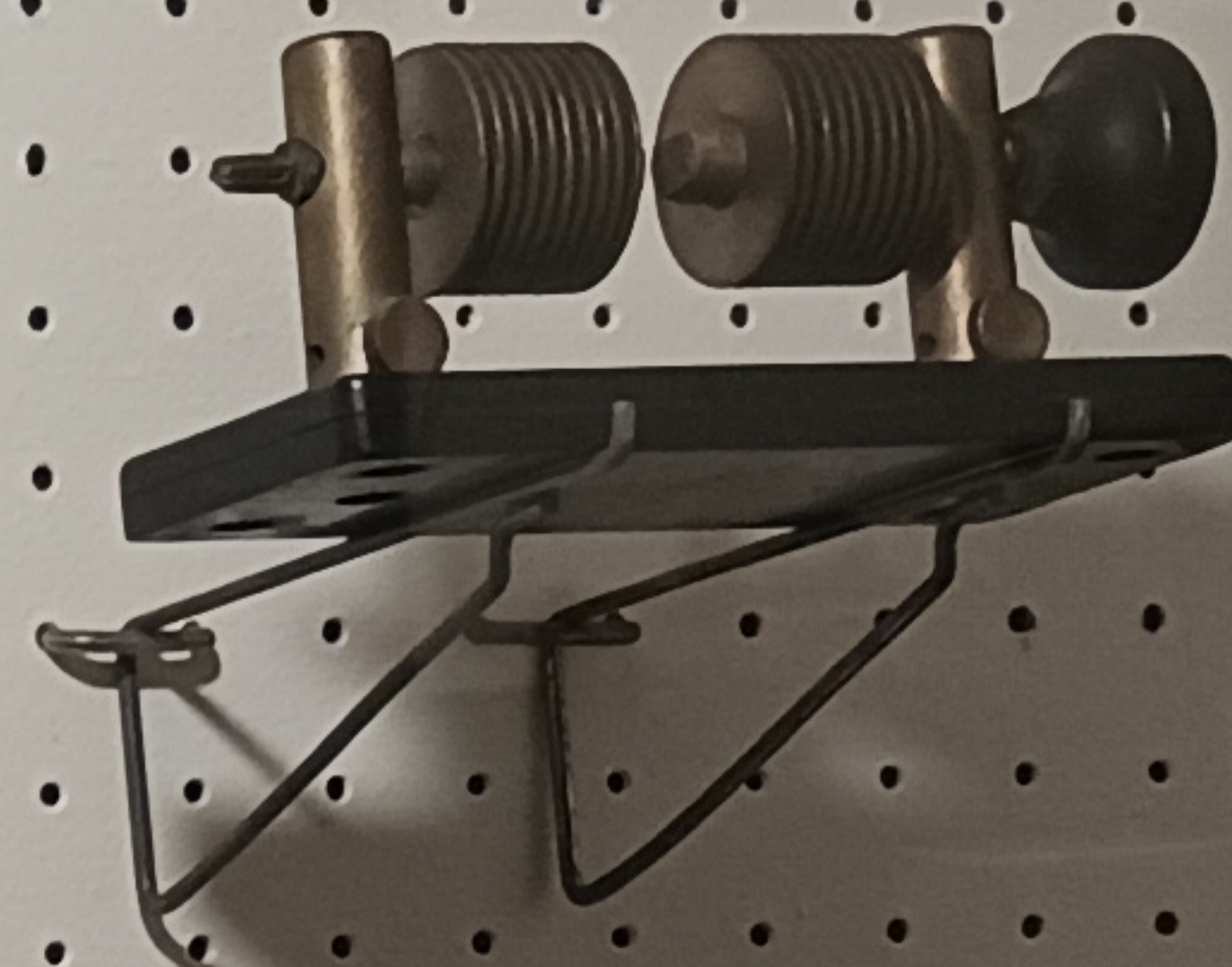
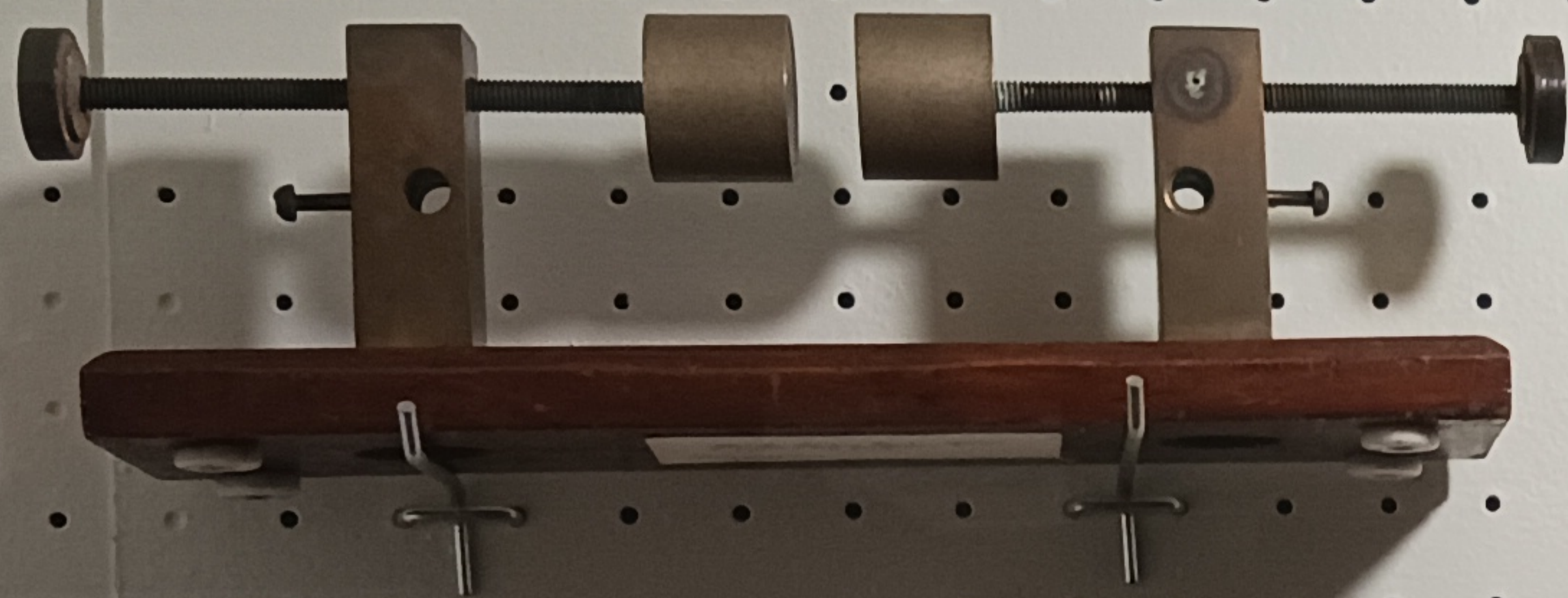
GIFT OF  
*Elden U. Benner* WIDOW



EDEN PARK  
ORS - R I - ARRL  
RDG AND MY "PUSHMOUTA" QRM MY "PULLENTA" 1-8 GF  
WATTS  
HARTLEY  
1ABP  
1-STEP  
BALDES  
WILLIAM J. CUMMINGS

Gift of Mrs. Albert Savage  
in memory of her brother  
LEN LUTHER WIDOW







1/2 KW  
**ROTARY SPARK GAP**  
FOR 500 CYCLE PER  
MADE FOR NAVY DEPARTMENT (BU S.E.) BY  
LOWENSTEIN RADIO CO. INC. BROOKLYN N.Y.  
REQ. NO. 14891 SA CONT. NO. 38279 DATE 1/10  
TYPE NO. 5E 64 SERIAL NO. 17741  
SEC. VOLTS 1100 MOTOR SUPPLY VOLTS 110

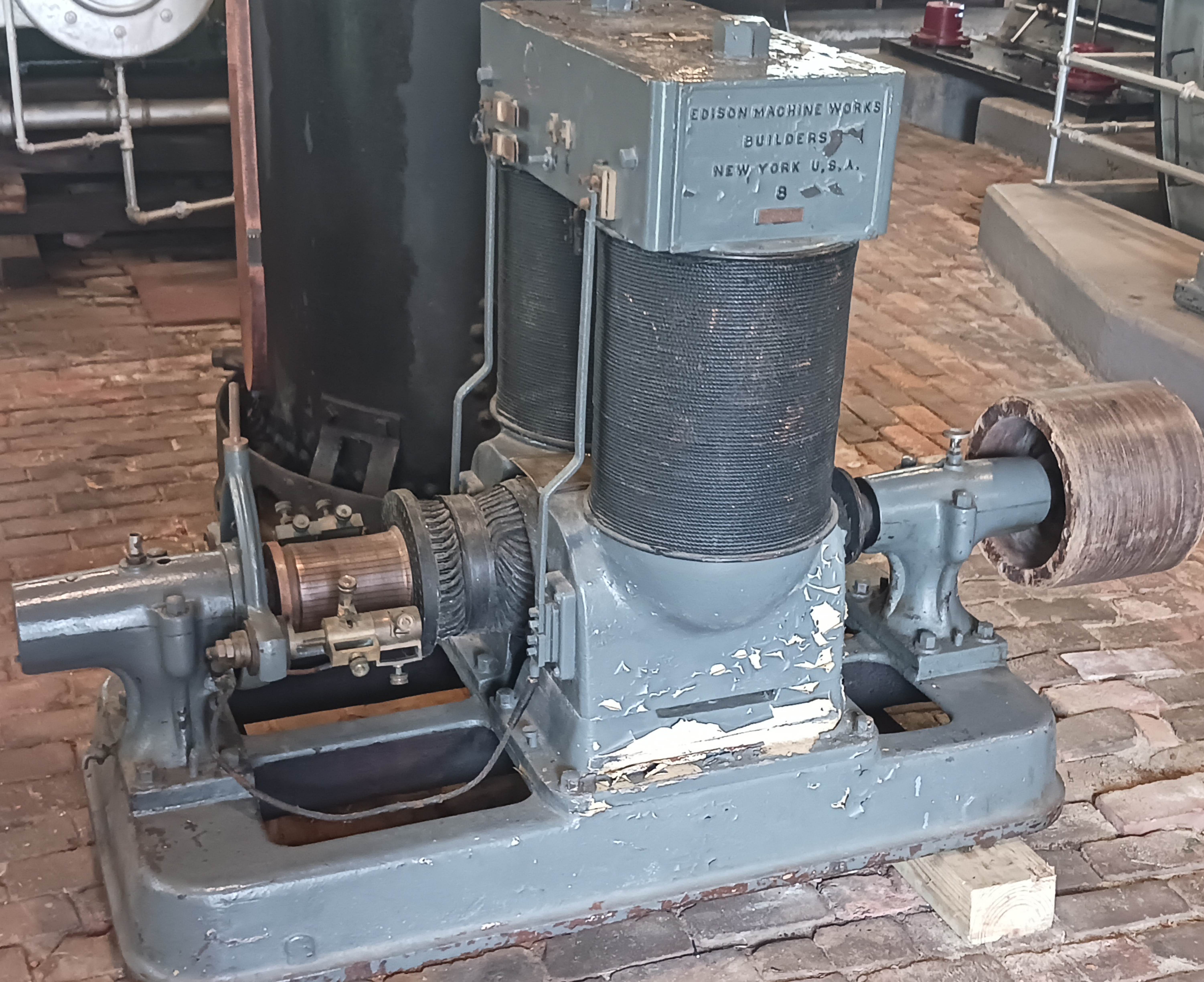














EDISON MACHINE WORKS  
BUILDERS  
NEW YORK U.S.A.  
8













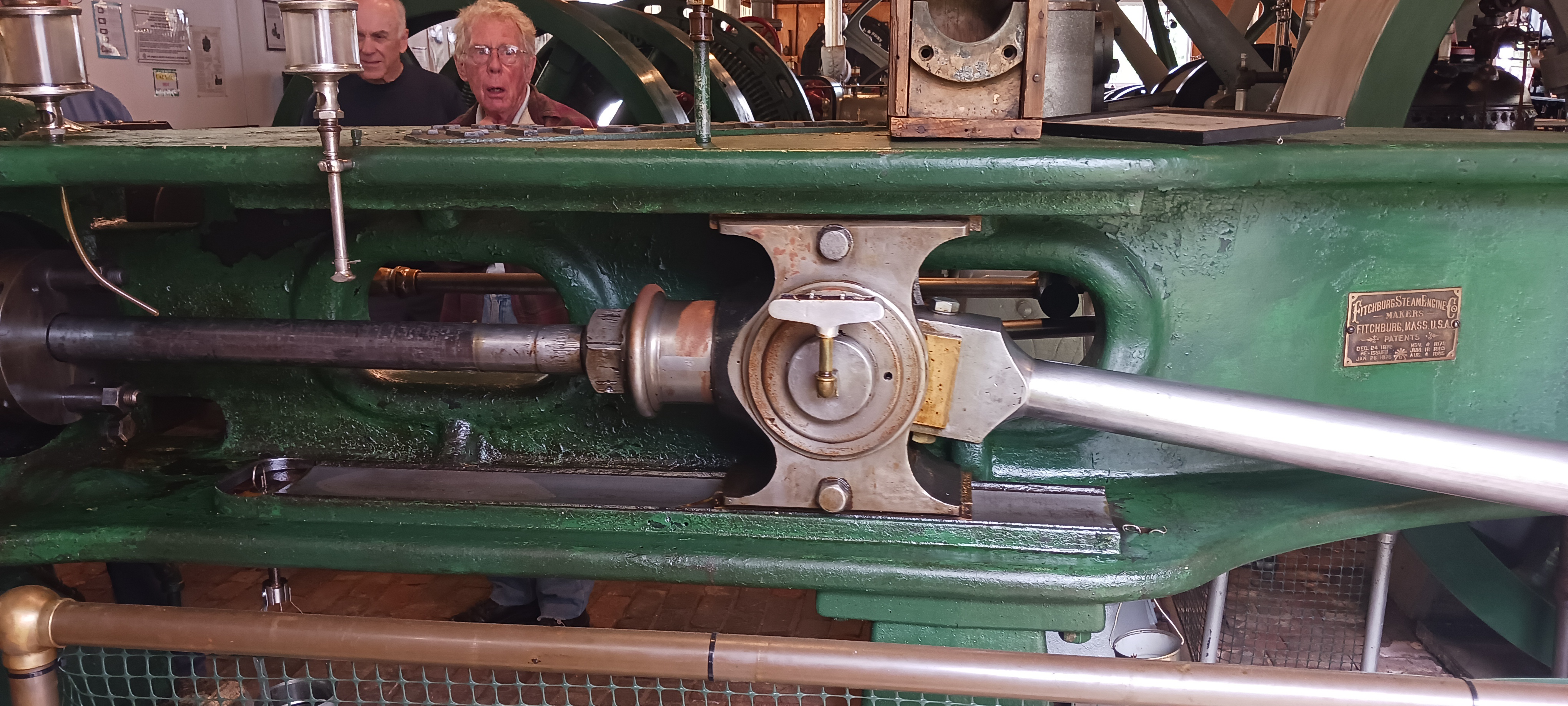






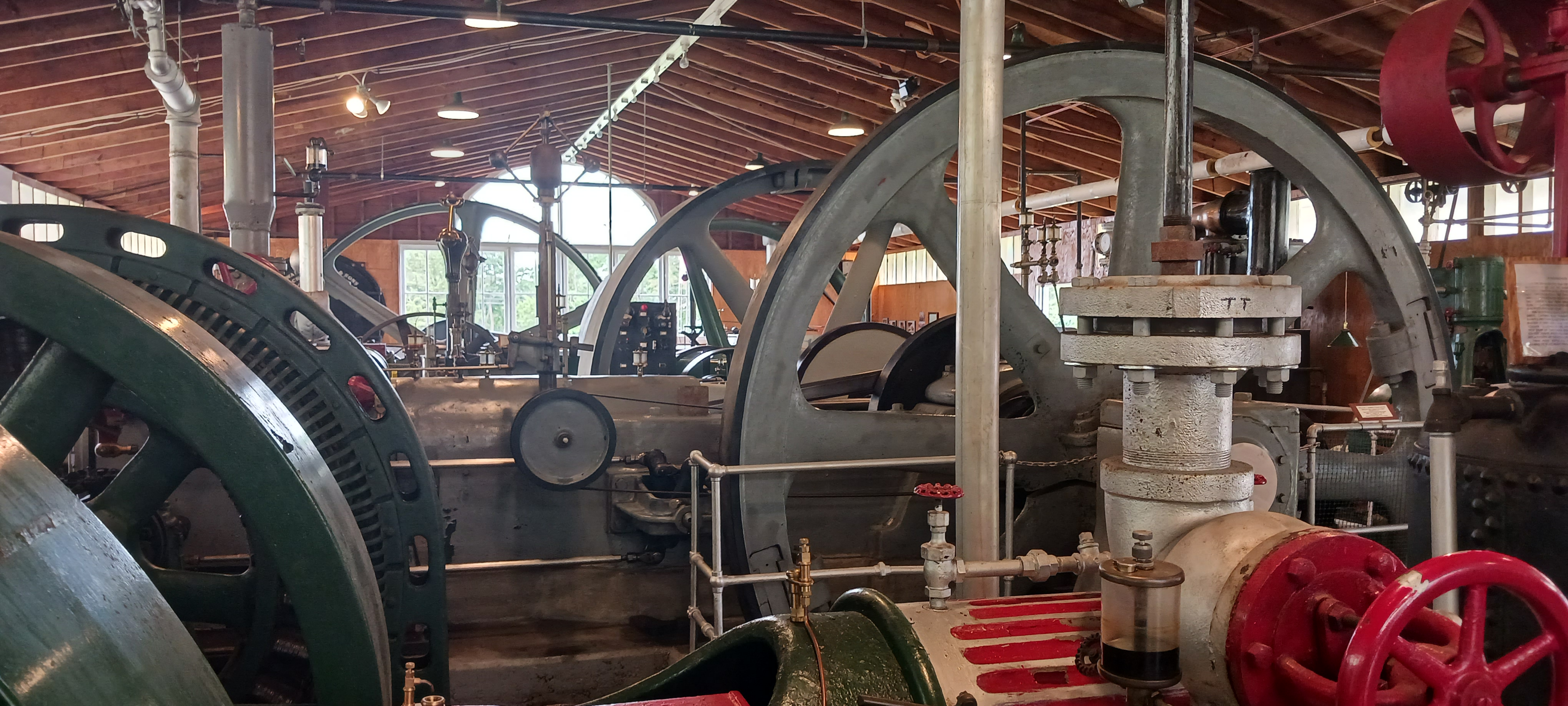
FITCHBURG STEAM ENGINE CO.  
— MAKERS —  
FITCHBURG, MASS. U.S.A.  
PATENTS  
DEC. 24 1875 NOV. 6 1875  
JAN. 18 1876 JULY 18 1875  
AUG. 4 1886



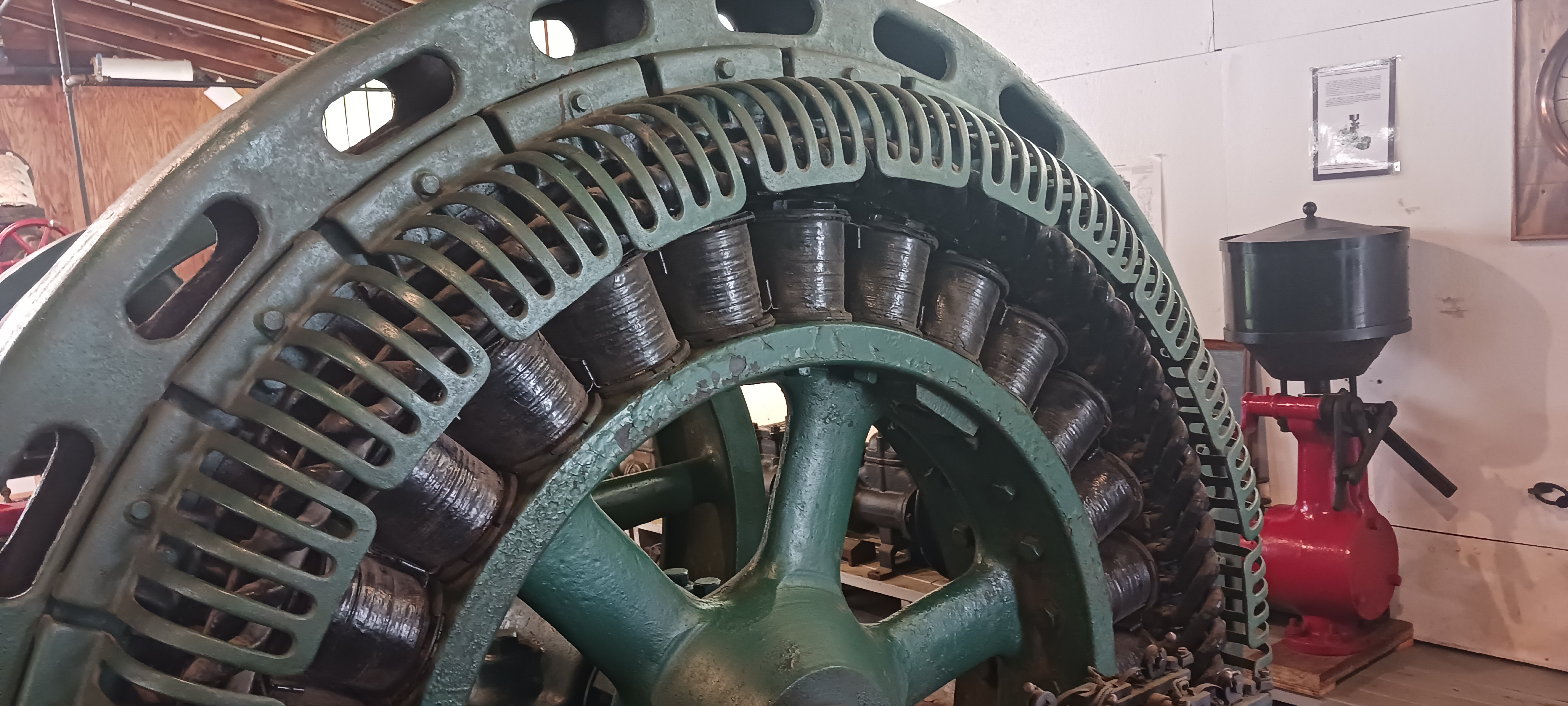


FITCHBURG STEAM ENGINE CO.  
MAKERS  
FITCHBURG, MASS. U.S.A.  
PATENTS  
DEC. 24 1877  
JAN. 26 1878  
NOV. 4 1879  
JUN. 17 1880  
AUG. 4 1881











THOMSON DYNAMO-ELECTRIC MACHINE  
NO. 7,573  
PATENTED-SEPT. 2, 79-JAN. 13, 80-JAN. 20, 80-OCT. 6, 80.  
JUN. 7, 81-FEB. 6, 83-JUL. 17, 83-APR. 8, 84.  
MANUFACTURED BY  
THOMSON-HOUSTON ELECTRIC CO.  
LYNN, MASS. U.S.A.















MARCH 2, 1889.

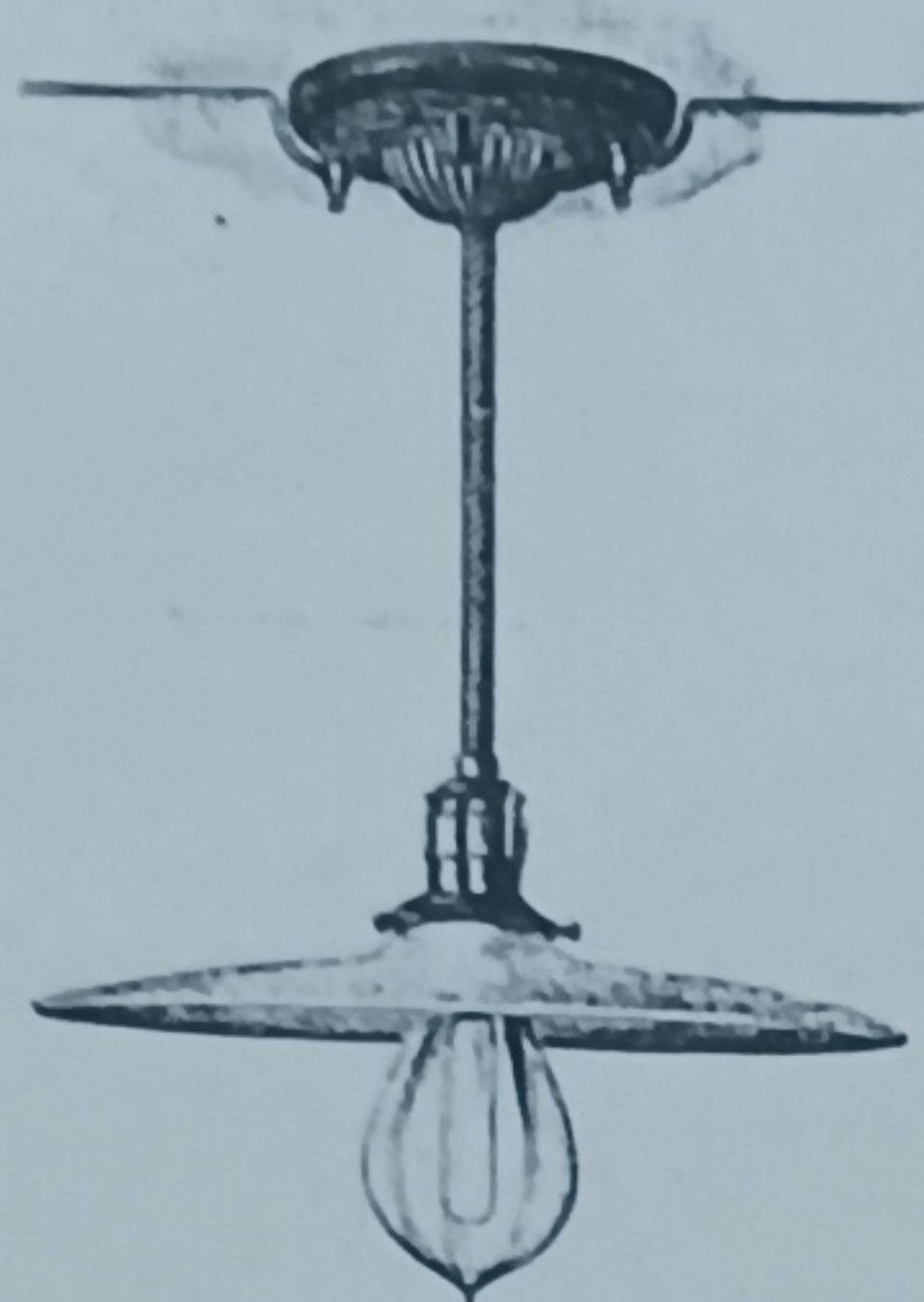
THE ELECTRICAL WORLD.

v

# THE THOMSON-HOUSTON DYNAMO FOR ARC LIGHTING

IS UNEQUALED IN

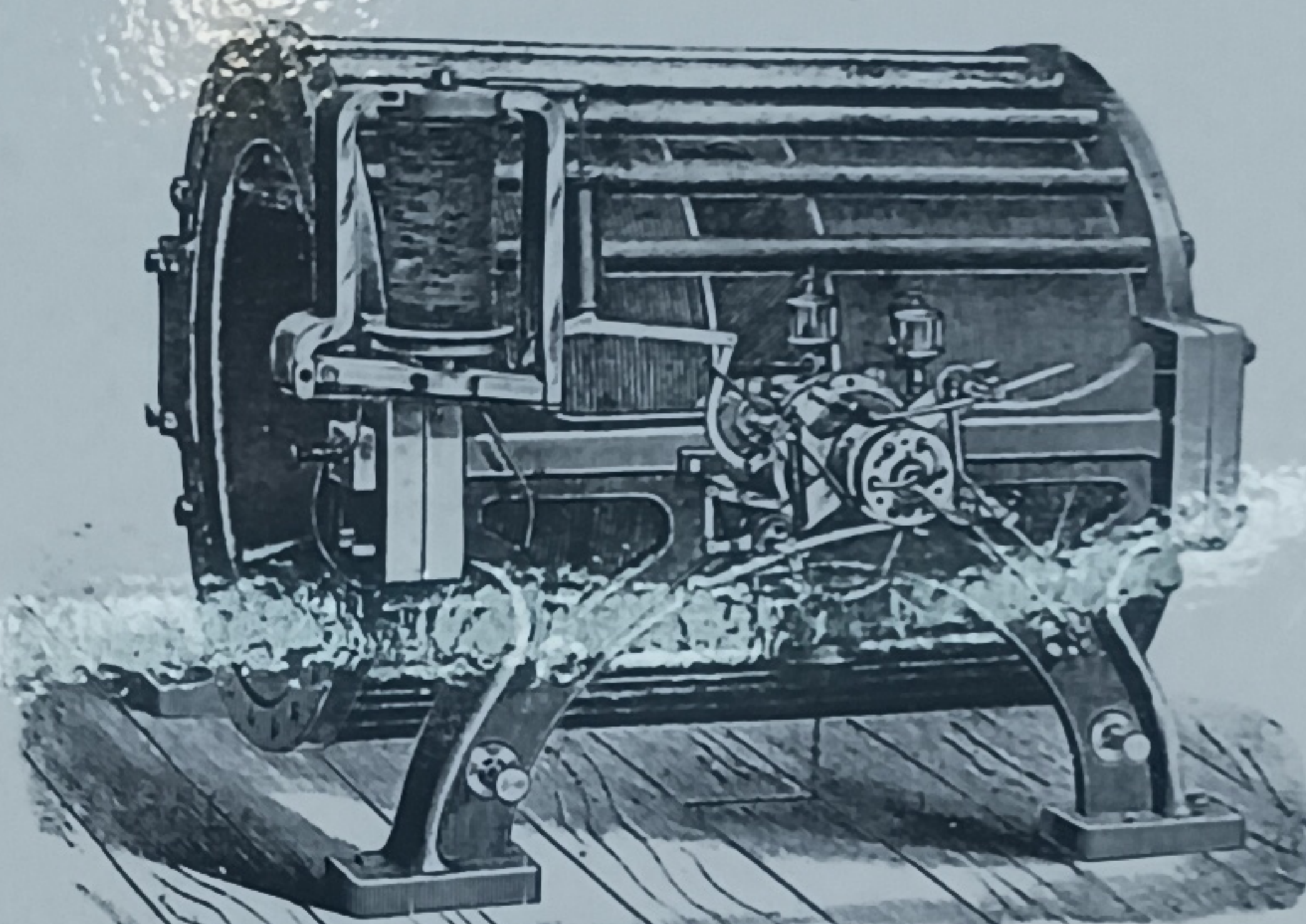
Economy of Operation and Automatic Regulation.



SERIES INCANDESCENT  
LAMP.

One of the most important features of the Thomson-Houston System of Arc Lighting is the facility with which Arc and Incandescent Lamps can be operated from the same dynamo and upon the same circuit, thus rendering it possible for local companies to supply both forms of light without use of a separate dynamo.

More than  
**400**  
Local Companies  
using this  
system.



Thomson-Houston Dynamo for Arc Lighting.

More than  
**50,000**  
ARC LAMPS  
in daily  
operation.

## THE THOMSON-HOUSTON LIGHTNING ARRESTER,

For use with Arc Dynamos, insures absolute protection of the apparatus from all danger of Lightning Discharges. The Thomson-Houston patents cover all practicable forms of Lightning Arresters for Arc and Incandescent Lighting Circuits.

## THE THOMSON-HOUSTON ELECTRIC COMPANY,

The Hathaway Building, 620 Atlantic Avenue, Boston, Mass

115 Broadway, New York.

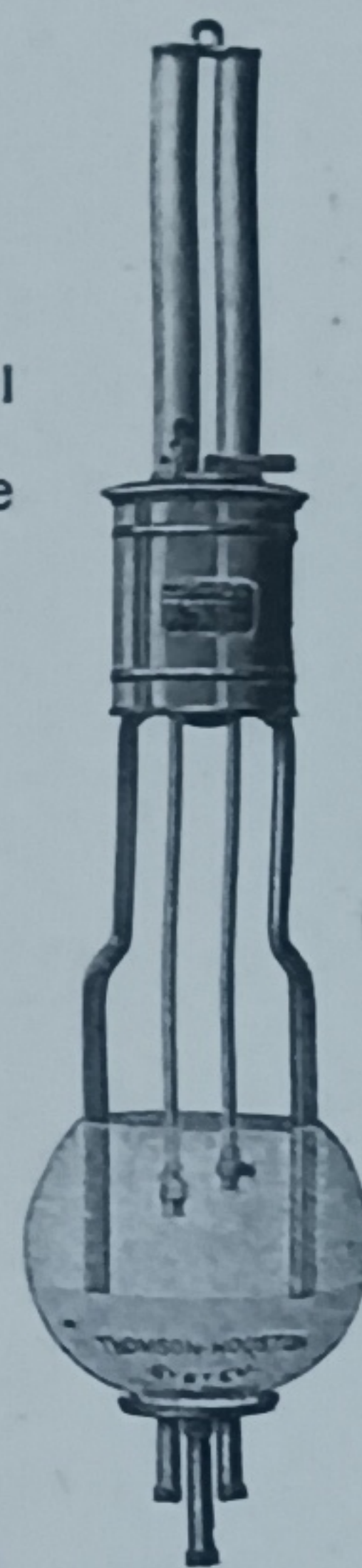
Kimball House Building, Atlanta, Ga.

503 Delaware Street, Kansas City, Mo.

148 Michigan Avenue, Chicago, Ill.

Globe Building, St. Paul, Minn.

234 Montgomery St., San Francisco, Cal.



ARC LAMP.

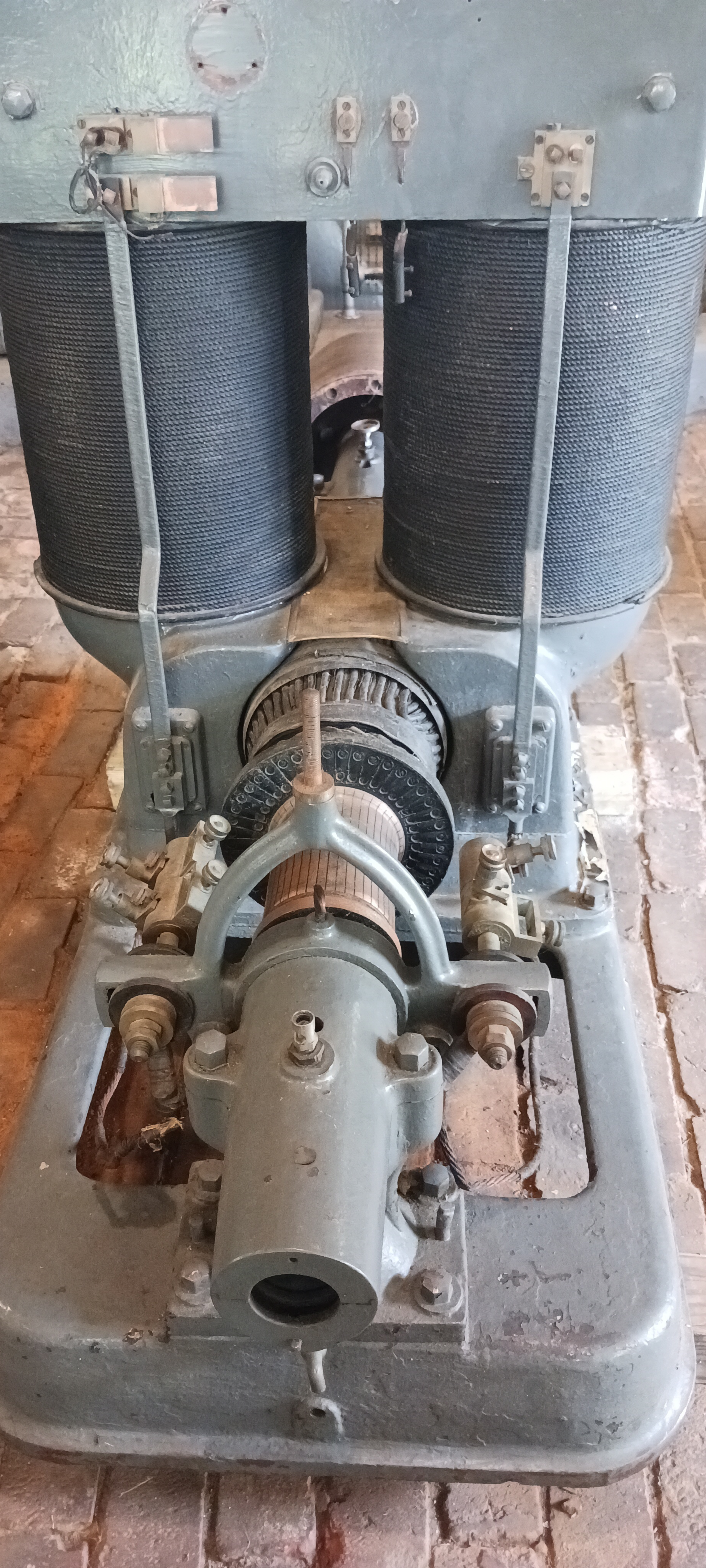














ALTERNATING CURRENT  
GENERATOR

NO. 559421    NAME 28 H 25 257  
FORM S    100    125  
AMP 3000    SPEED 257  
VOLTS NO LOAD    FULL LOAD 240

GENERAL ELECTRIC CO.  
SCHENECTADY, N.Y. U.S.A.



WESTERN  
ELECTRIC  
COMPANY

CHICAGO—NEWYORK

TYPE **E4A01S** K.W. **6**

NO **35128** SPEED **664**

VOLTS **110 155** AMP **54.5 38.7**

VOLTS NO LOAD **110 155**  
FULL LOAD





WESTERN  
ELECTRIC  
COMPANY  
CHICAGO - NEW YORK  
TYPE  K.W.   
H.P.  SPEED   
VOLTS  AMP   
VOLTS  AMP













211051463

211051463



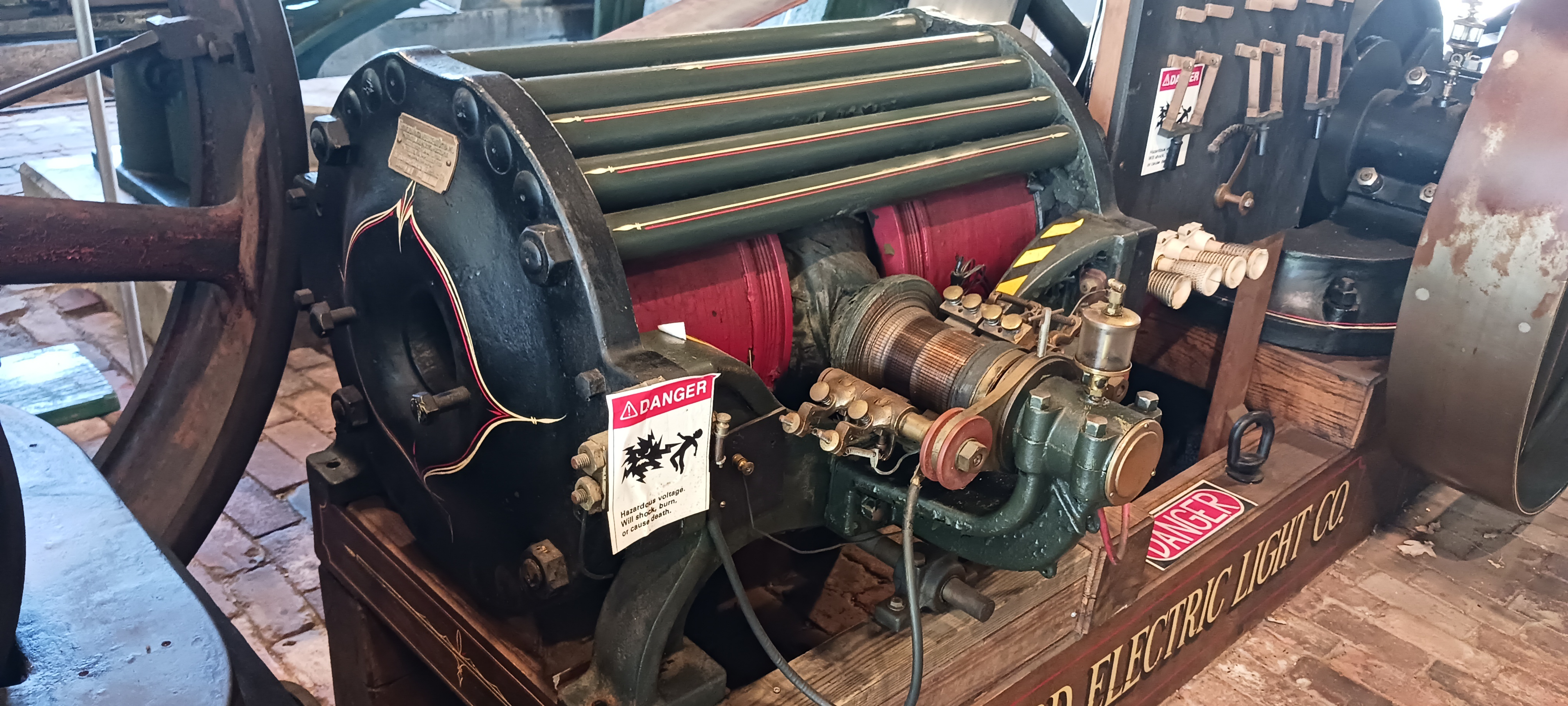
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**THOMSON-  
HOUSTON  
ELECTRIC CO.**

SERIAL NO. 78  
STATED CAPACITY  
28 LIGHTS  
CLASS E-1



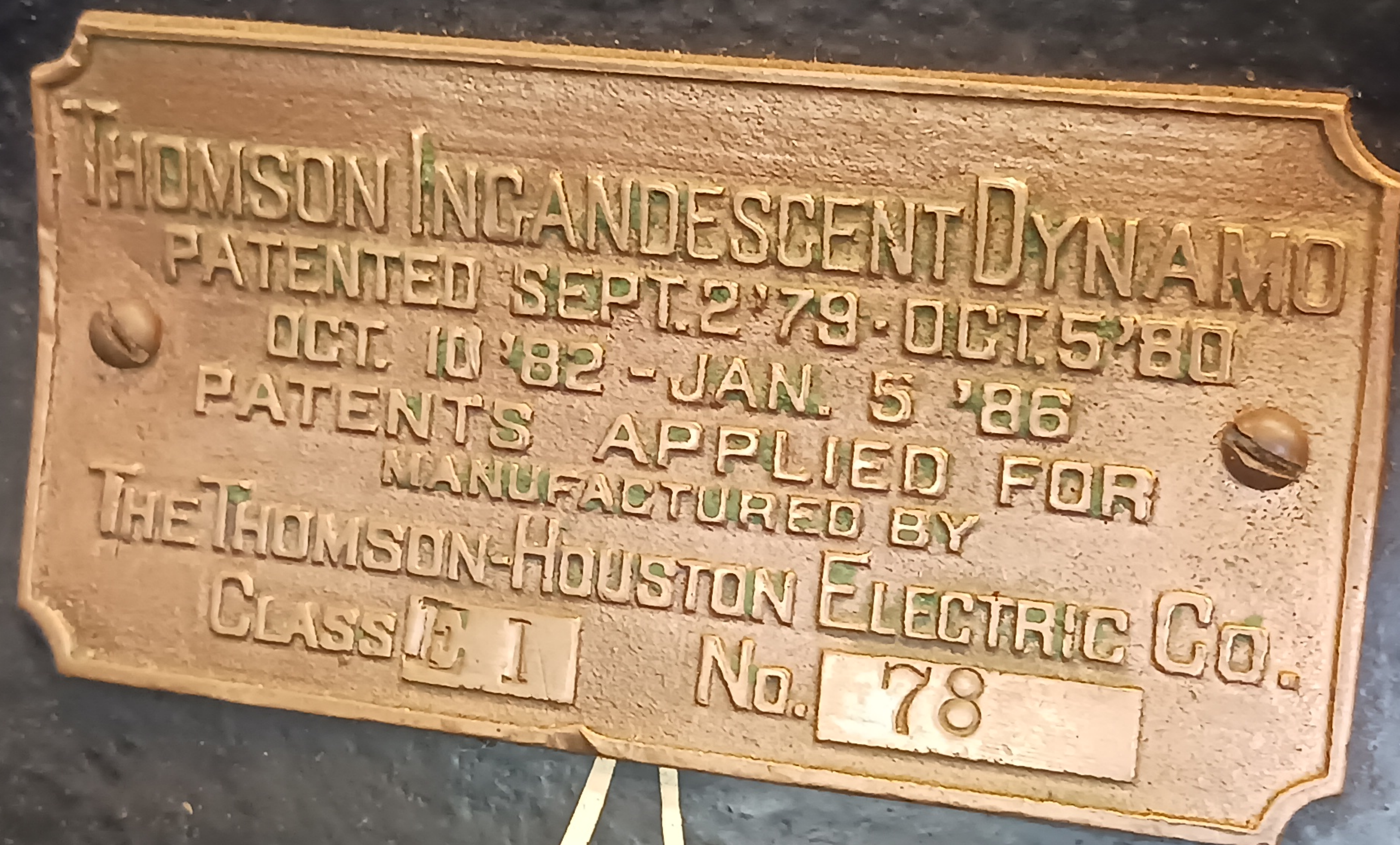




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Hazardous voltage.  
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THOMSON INCANDESCENT DYNAMO

PATENTED SEPT. 2 '79 - OCT. 5 '80

OCT. 10 '82 - JAN. 5 '86

PATENTS APPLIED FOR

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CLASS E 1

No. 78





CONNECT  
TO GRID



MAIN  
SWITCH

ARTIFICIAL  
LOAD

FIELD  
RHEOSTAT



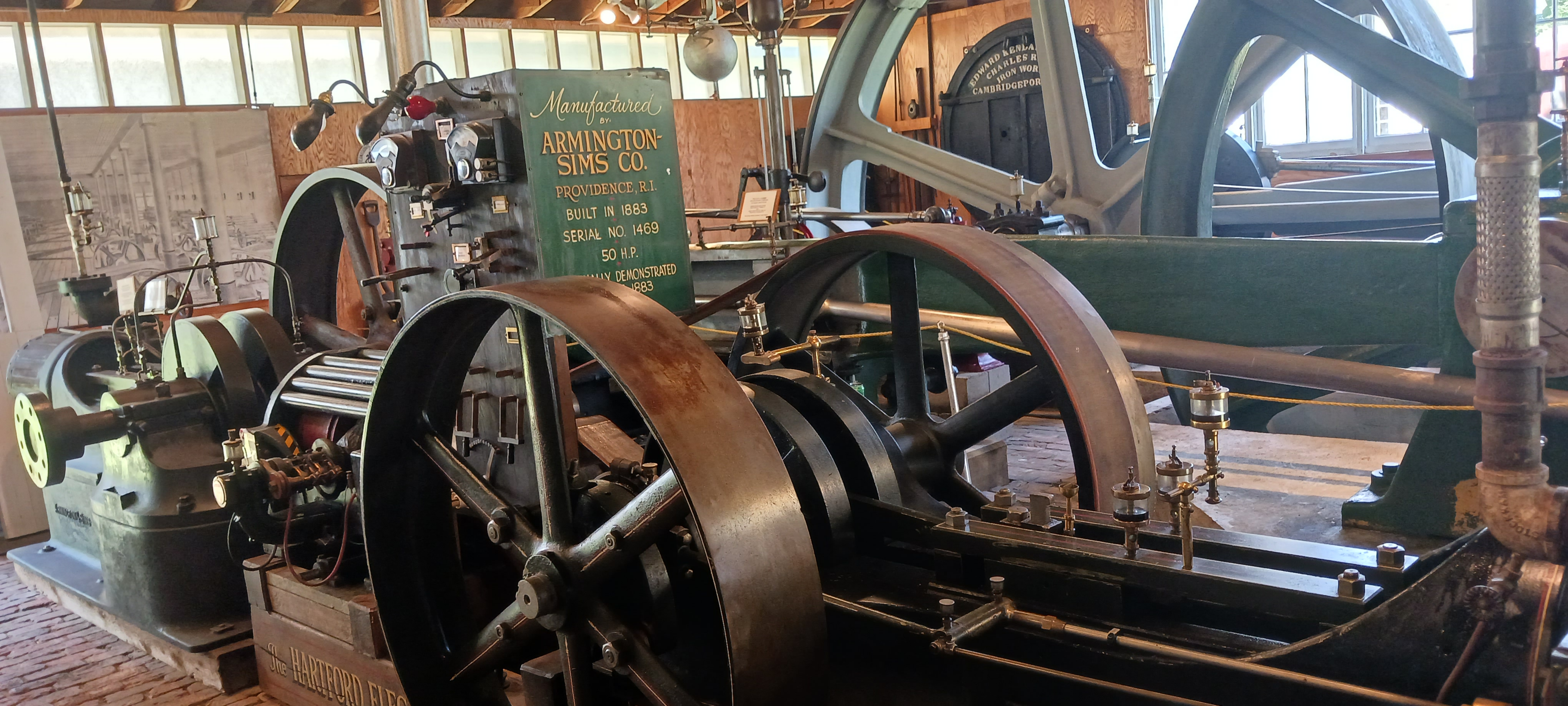
LOCAL  
LAMPS

ARTIFICIAL  
LOAD

ARTIFICIAL  
LOAD







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1883

EDWARD KENLA  
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The HARTFORD ELECTRIC



AUTOMATIC REGULATOR NO. 1  
PATENTED - JAN. 20 '80 - MAR. 1 '81 - DEC. 26 '82 - FEB. 6 '83  
THOMSON-HOUSTON ELECTRIC CO.  
LYNN, MASS. U.S.A.

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### THE SPECTROSCOPE IN USE

When the light waves from any flame are passed through a glass prism, certain definite lines are seen in the spectrum produced, and by means of these we can detect very small quantities of matter, and distinguish one elementary substance from another. It is by this means we have learned the constituents of the heavenly bodies.



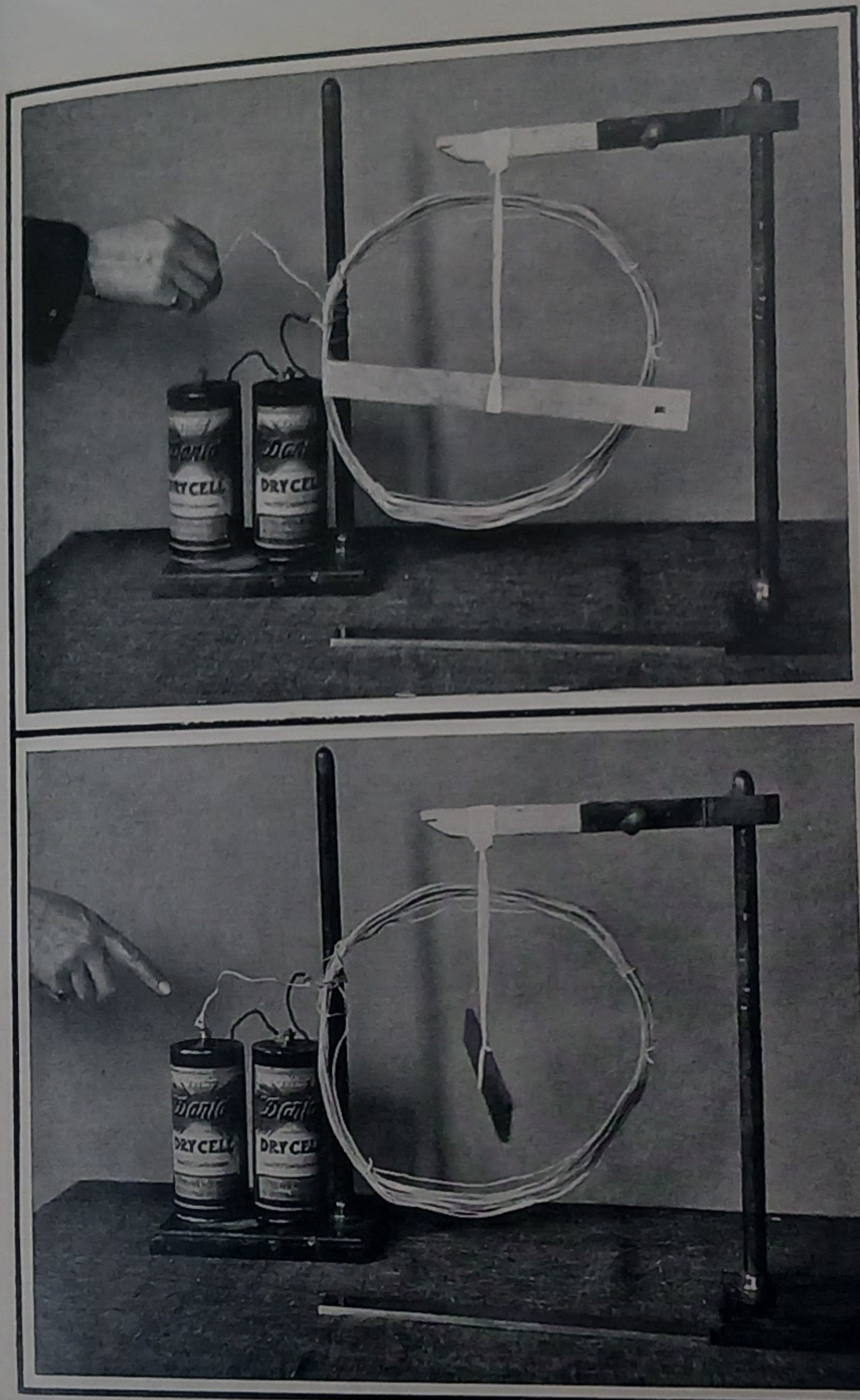
## Scientific Ideas of To-day

disturbance which, at some great distance, is again transformed into the vibratory motion of other particles of matter.

When we speak to a distant friend by telephone, it is obvious that no sound passes from the one town to the other. The sound produced by the speaker controls an electric current which passes out to the distant station, and there it sets a metal diaphragm in motion, which causes the surrounding air to vibrate and reproduce the distant controlling sound. Just as no sound passes between the two distant places, no heat passes between the Sun and the Earth. In both cases there is a real transformation and reproduction.

It is only at the outset that the novice shakes his head at any mention of the æther. His first inclination is to say that we might as well talk about "the man in the moon." He may say that scientists have merely invented the idea of the æther to help them out of difficulties. The scientist admits the accusation. The idea of the æther was suggested by a great Dutch philosopher, Huygens,<sup>1</sup> more than two hundred years ago, to explain the phenomena of light. Sir Isaac Newton's more materialistic theory was much more popular, and even when the original philosopher, Dr. Thomas Young (London), adopted and worked out this æther idea, he met with little encouragement from scientific men. It is amusing to turn to an old number

<sup>1</sup> Long before this time æthers had been invented for the planets to swim in, and indeed to help the ancient philosophers out of any apparent difficulty, but the æther as we now accept it was definitely suggested by Huygens at the close of the seventeenth century.



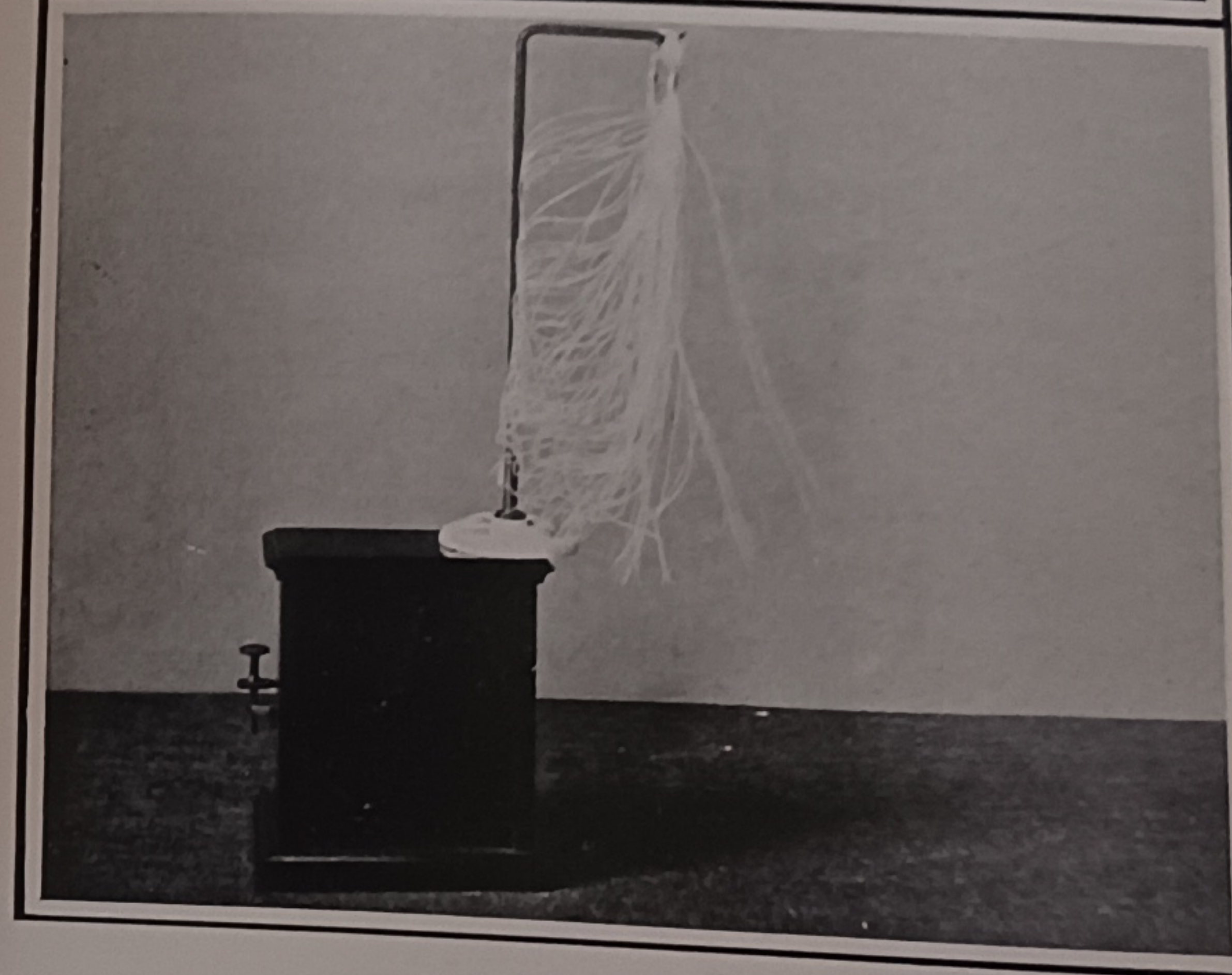
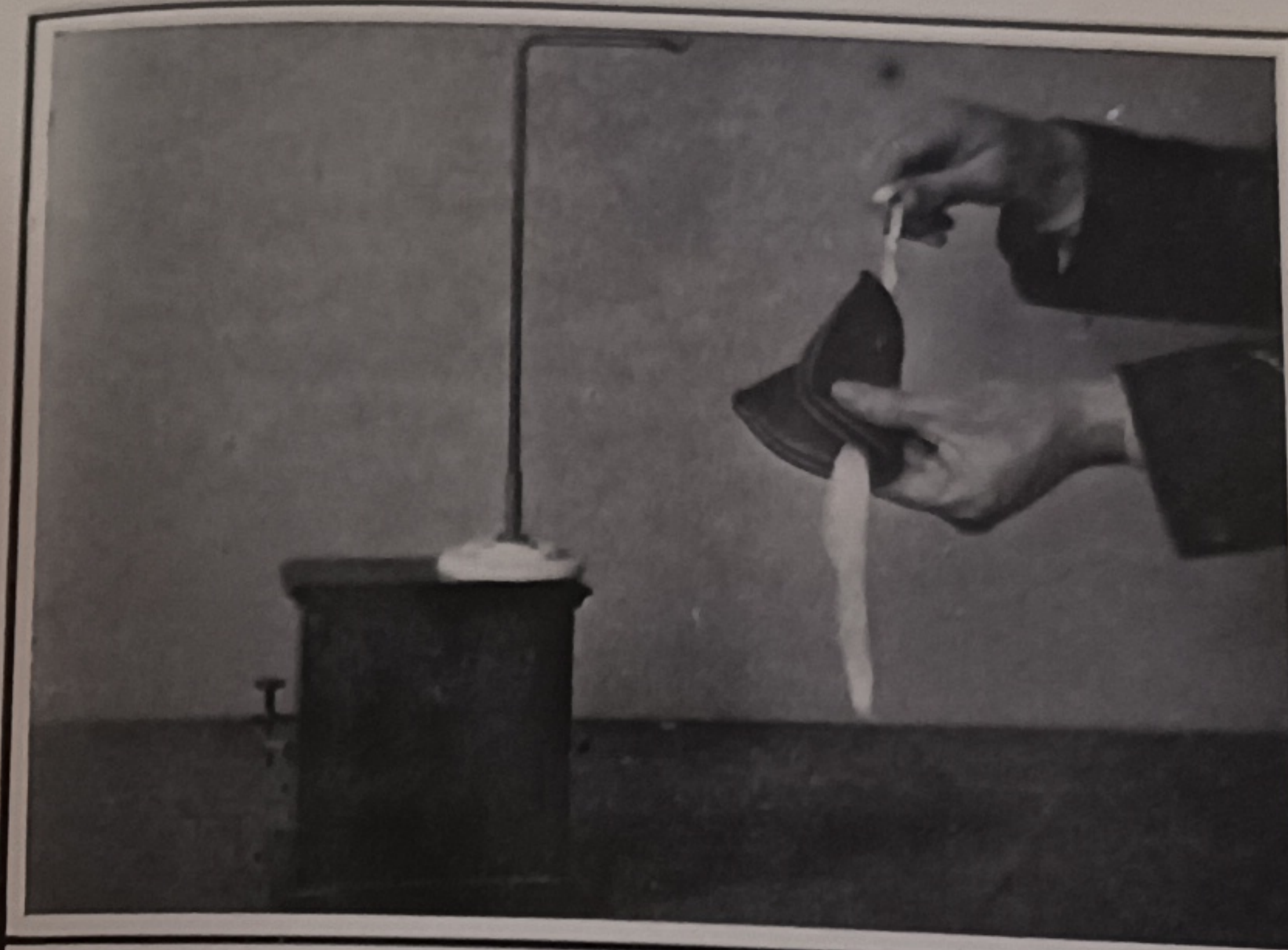
A COIL OF WIRE CARRYING AN ELECTRIC CURRENT BEHAVES LIKE A MAGNET

In the upper illustration the battery is not connected to the coil. When the circuit is completed the large steel magnet swings round and takes up a position at right angles to the face of the coil, as in the lower photograph.



ideas of To-day  
 any atom may readily give up some of its electrons to any other atom which happens to be below it in the scale. We picture the atom which is capable of accepting electrons to be electro-negative, for it will then have surplus electrons; the atom losing electrons will represent the electro-positive atom. We picture a certain kind of atom giving electrons to another atom lower down in the scale, and we say the former is electro-positive; but at the same time we see that this same electro-positive atom is able to accept electrons from another kind of atom which is still higher in the scale, and in this case it is no longer electro-positive, but becomes electro-negative.

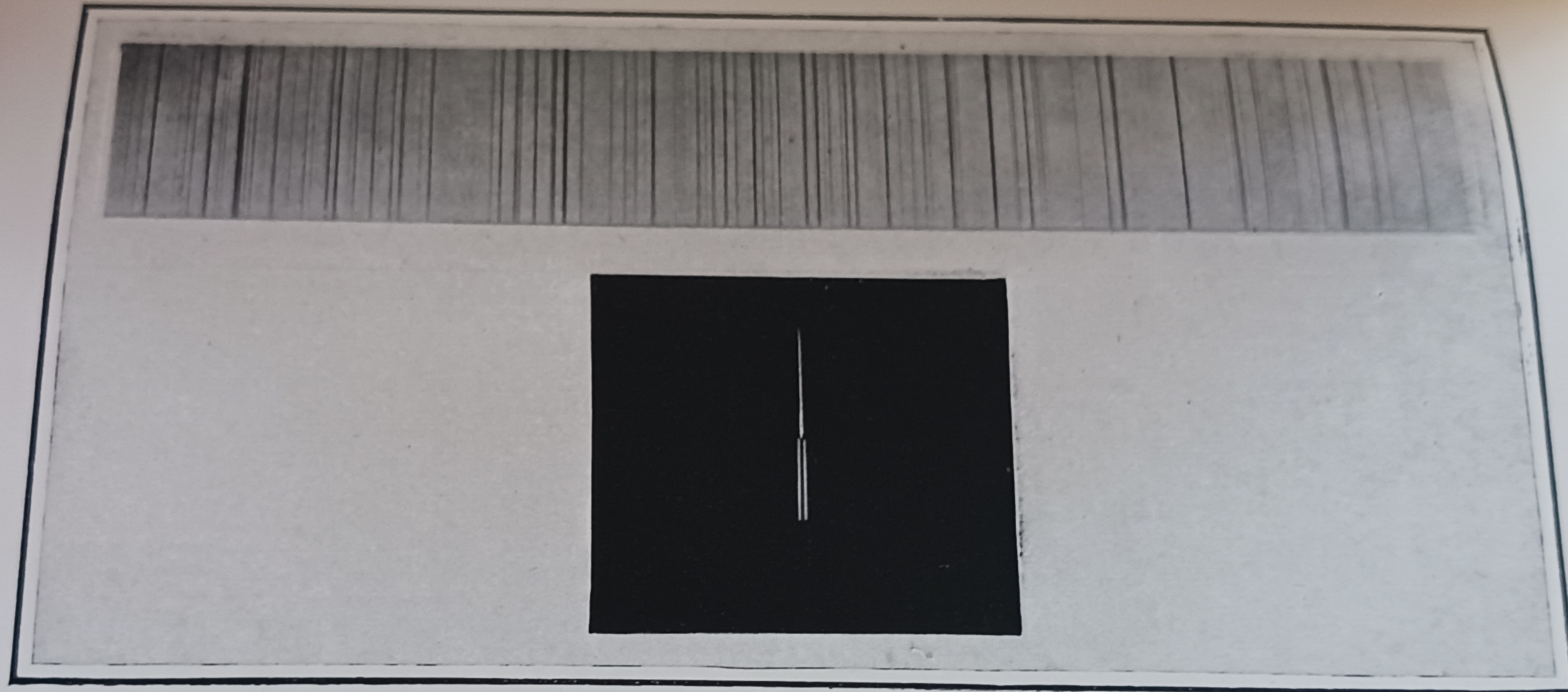
While the foregoing analogy may be of some assistance, it is not complete. For instance, it does not take into account the fact that two atoms of the same element—say oxygen—unite together to form a molecule of oxygen. Our analogy would suppose that because both atoms are on the same level on the scale neither could throw electrons at the other. The physicist can adduce reasons, however, for supposing that when two atoms of the same element come so near together that the revolving electrons in the one atom can exert force upon the revolving electrons in the other, there is an interchange of electrons which causes one of the atoms to become electro-negative to the other. In this way we may still picture two atoms of oxygen as being electrically united to form a molecule of oxygen.



ELECTRICAL REPULSION

If a tassel of ordinary sewing silk be briskly rubbed with a rubber tobacco pouch, the silk threads will become similarly electrified and will therefore repel each other, as seen in the lower photograph. The electrified threads will attract any unelectrified body, so that those threads near the upright stand cling to it.





(1) DARK LINES IN THE SOLAR SPECTRUM

(2) ZEEMAN EFFECT

The upper illustration is part of a photograph of the solar spectrum. The meaning of the dark lines which appear in the photograph is explained at page 226.

The lower photograph is a double one. First of all a single spectral line of sodium was photographed. Then a powerful magnetic field was applied to the sodium flame, and the second photograph was taken showing the same line split into two lines. See page 241.

This photograph was taken in the late Lord Blythswood's laboratory.

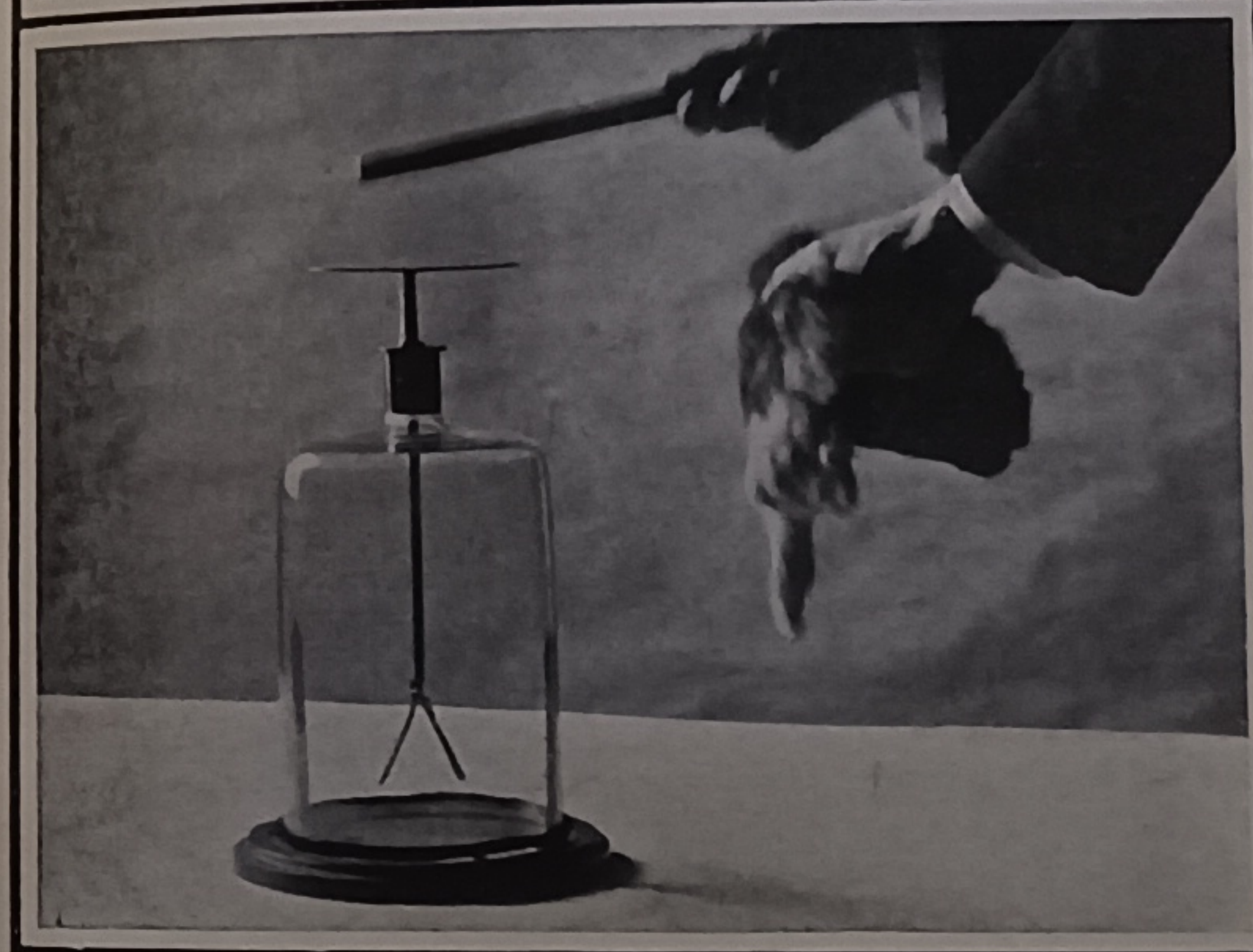
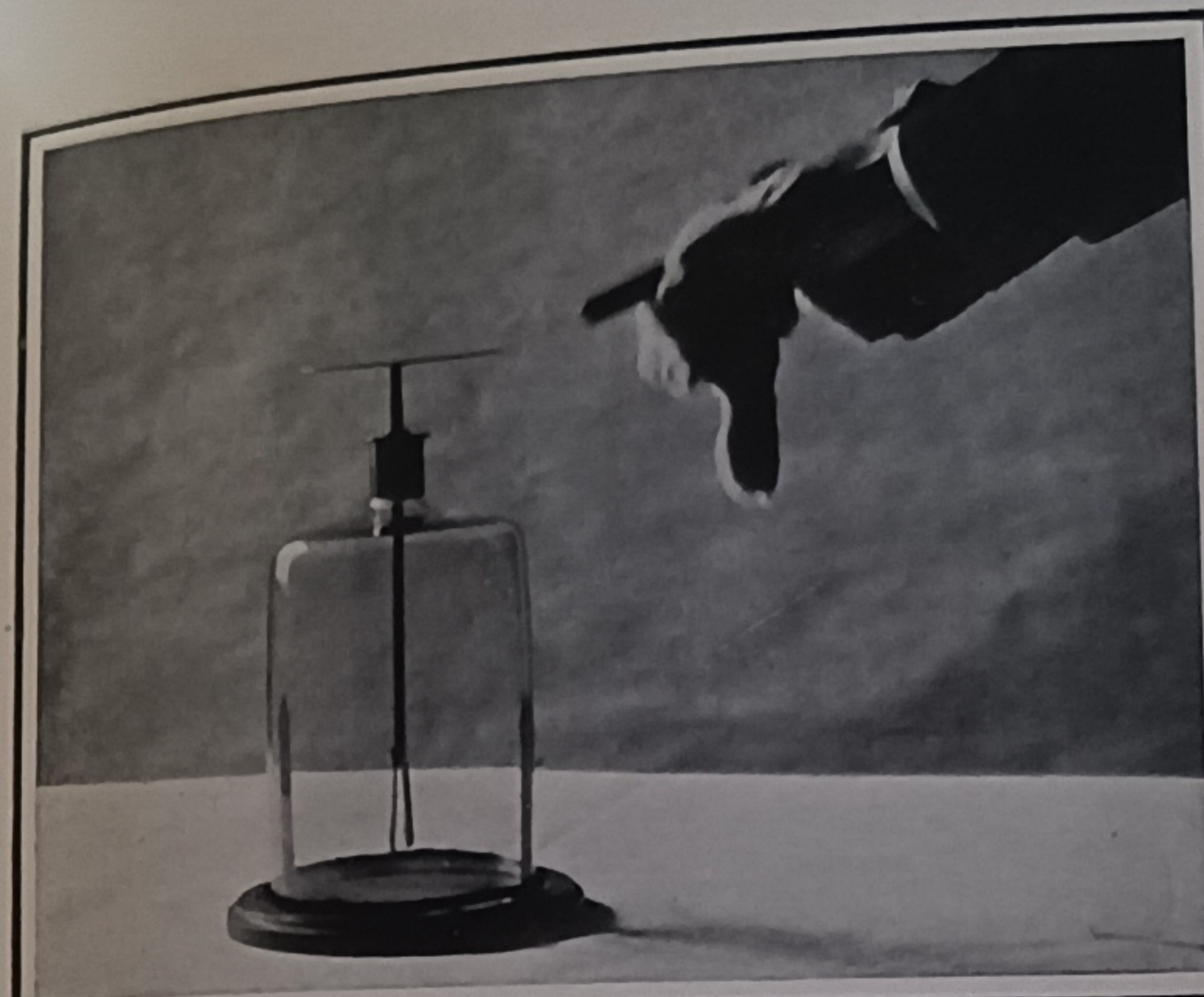


## Scientific Ideas of To-day

number disintegrating per second, we find that the gramme of radium should last about three thousand years. This is only a very rough way of expressing the facts, for, as the radium's volume decreases, it will not lose the same quantity each year. The more it disintegrates the more slowly will the remainder break down. It is because of this law that it is more convenient to say that radium will disintegrate half its atoms in about thirteen hundred years.

In accordance with the same law we find that although the emanation of radium takes a few weeks to completely break down, yet one-half of it has disappeared at the end of the first four days. Dealing with uranium in the same way, we say that half its quantity would disappear at the end of six hundred million years.

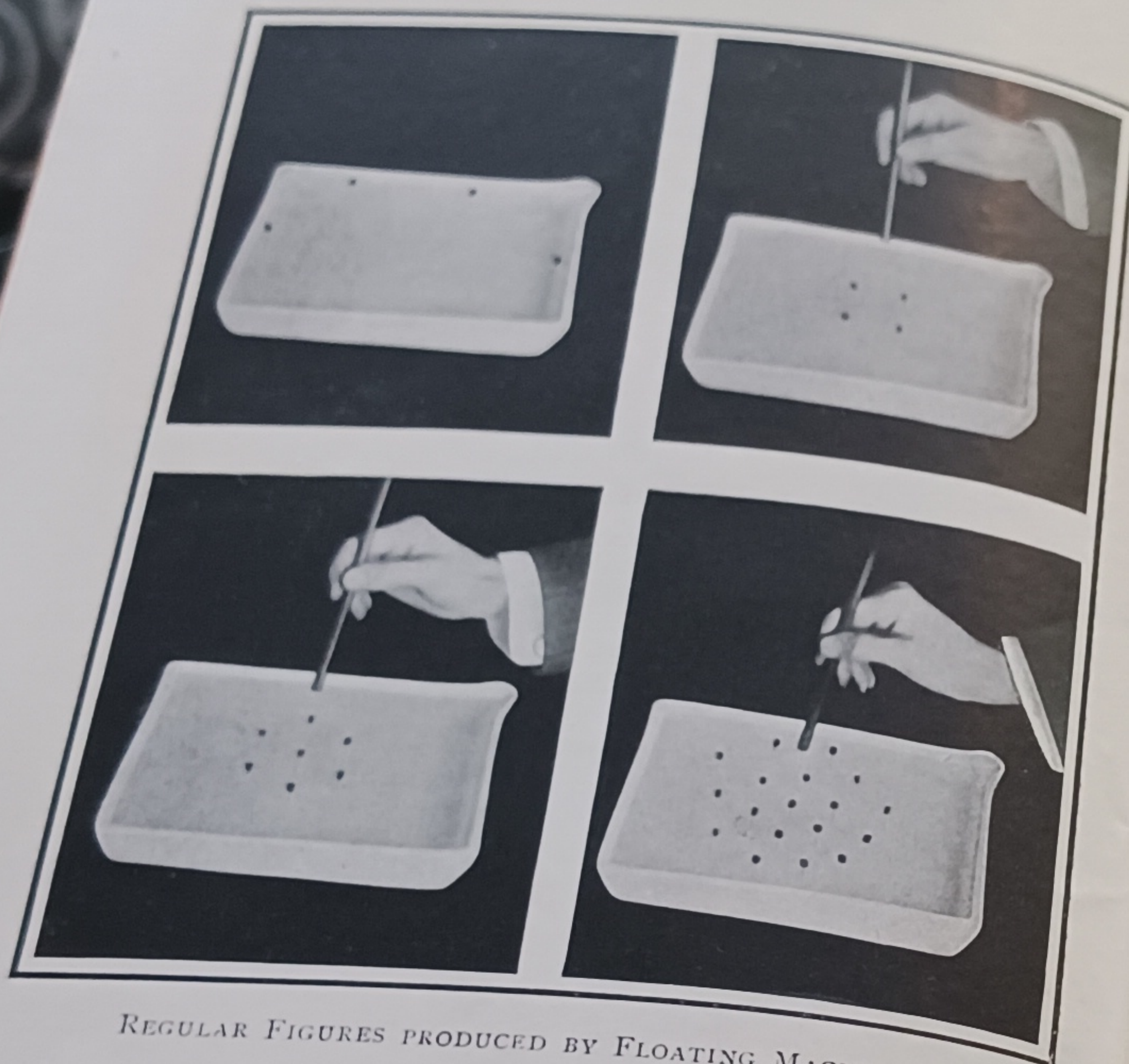
It is interesting to note that these various rates of decay, or disintegration, are constant and can neither be hastened or retarded by man. It would not be wise to be dogmatic and say that man will never be able to hasten the natural rate of disintegration of radio-active bodies. Who could have believed, a century ago, that we could ever get particles smaller than atoms to transmit enormous quantities of energy from place to place? And yet that is what really happens when we send electric power along a stationary wire. Who could have believed that we should ever get these invisible particles to carry our speech to distant towns, and to bring us immediate intelligence of what is happening in all parts of the civilised world?



THE ELECTROSCOPE IN USE

An insulated metal rod with two pieces of gold leaf attached to its lower end is protected by a glass jar. When any electrified body is brought near the metal disc attached to the upper end of the rod, the gold leaves become electrically charged and repel each other, as shown in the lower photograph. The presence of radium may be detected by an electroscope which has been charged previously, as explained in the text.





REGULAR FIGURES PRODUCED BY FLOATING MAGNETS

In the first photograph the little upright magnetic needles may be seen projecting downwards from the small corks. Left alone, the similar poles repel one another, but in the other photographs the hand holds the opposite pole of a magnet above the centre of the basin, whereupon the little magnets invariably form definite figures according to their number. These experiments enable us to form a mental picture of the construction of the atom.

# SCIENTIFIC IDEAS OF TO-DAY

A POPULAR ACCOUNT OF THE NATURE  
OF MATTER, ELECTRICITY, LIGHT,  
HEAT, &c. &c.  
IN NON-TECHNICAL LANGUAGE

By  
CHARLES R. GIBSON, F.R.S.E.  
Author of "Electricity of To-Day," "The Romance of Modern  
Electricity," "The Romance of Modern Photography,"  
&c. &c.

With Forty-two Illustrations and Diagrams

SEVENTH EDITION, REVISED & BROUGHT UP TO DATE

London  
Seeley, Service & Co. Limited  
196 Shaftesbury Avenue  
MDCCCCXXV



# SOUND

BY

JOHN TYNDALL, D.C.L., LL.D., F.R.S.



NEW YORK  
P. F. COLLIER & SON  
MCMV



rod as a whole to number 58, then the vibrations corresponding to this and to its successive divisions would be expressed approximately by the following series of numbers:  
 36, 225, 625, 1225, 2025, etc.

In Fig. 58, a, b, c, d, e, are shown the modes of division corresponding to this series of numbers. You will not fail to observe that these overtones of a vibrating

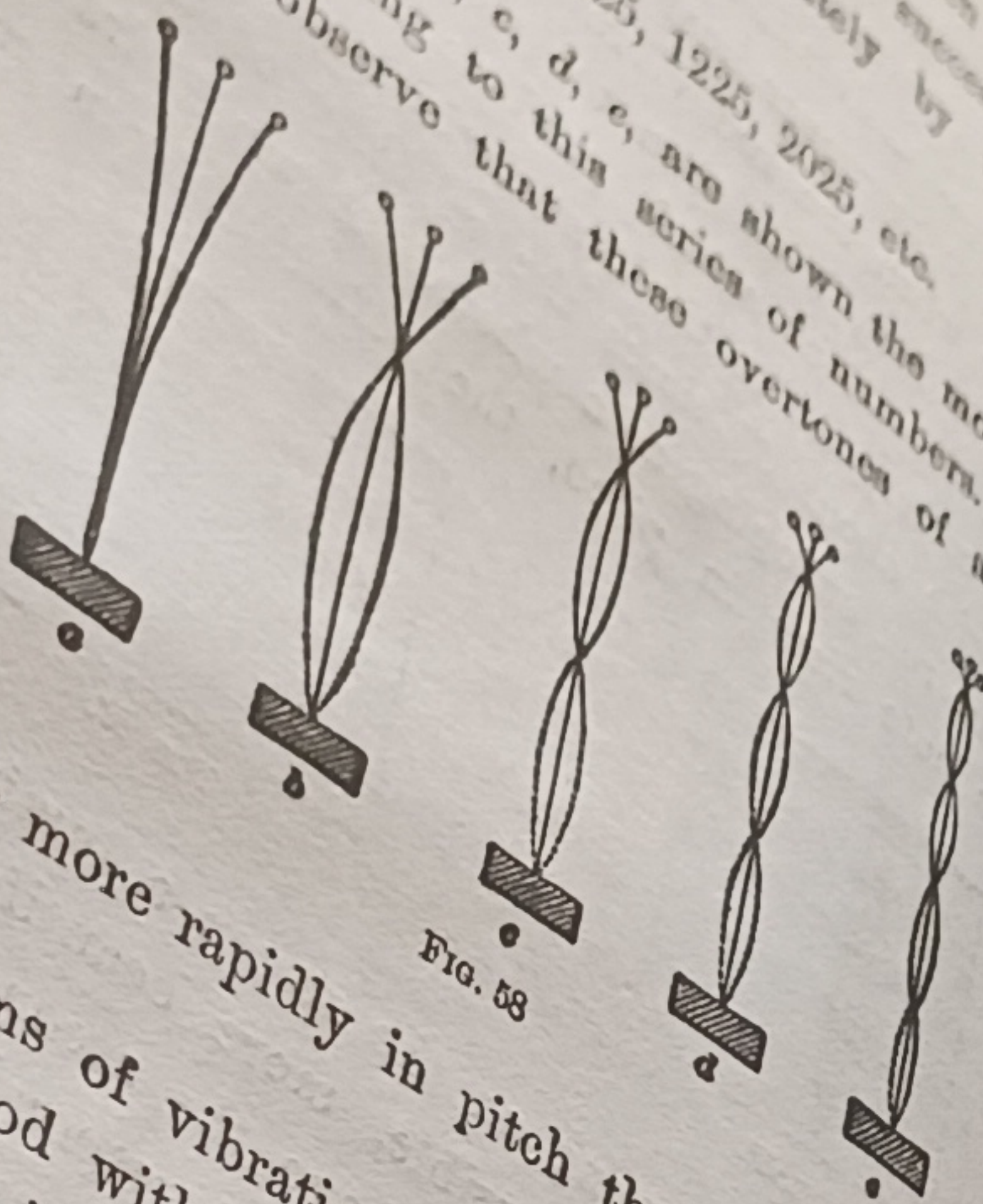


FIG. 58

rod rise far more rapidly in pitch than the harmonics of a string. Other forms of vibration may be obtained by smartly striking the rod with the finger near its fixed end. In fact, an almost infinite variety of luminous scrolls can be thus produced, the beauty of which may be inferred from the subjoined figures (see next page) first obtained by Sir C. Wheatstone. They may be produced by illuminating the bead with sunlight, or with the light of a lamp or candle. The scrolls, moreover, may be doubled by employing two candles instead of one. Two spots of light then appear, each of which describes its own luminous line when the knitting-needle is set in vibration.

SOUND

In the subsequent lecture we shall become acquainted with Wheatstone's application of his method to the study of rectangular vibrations.

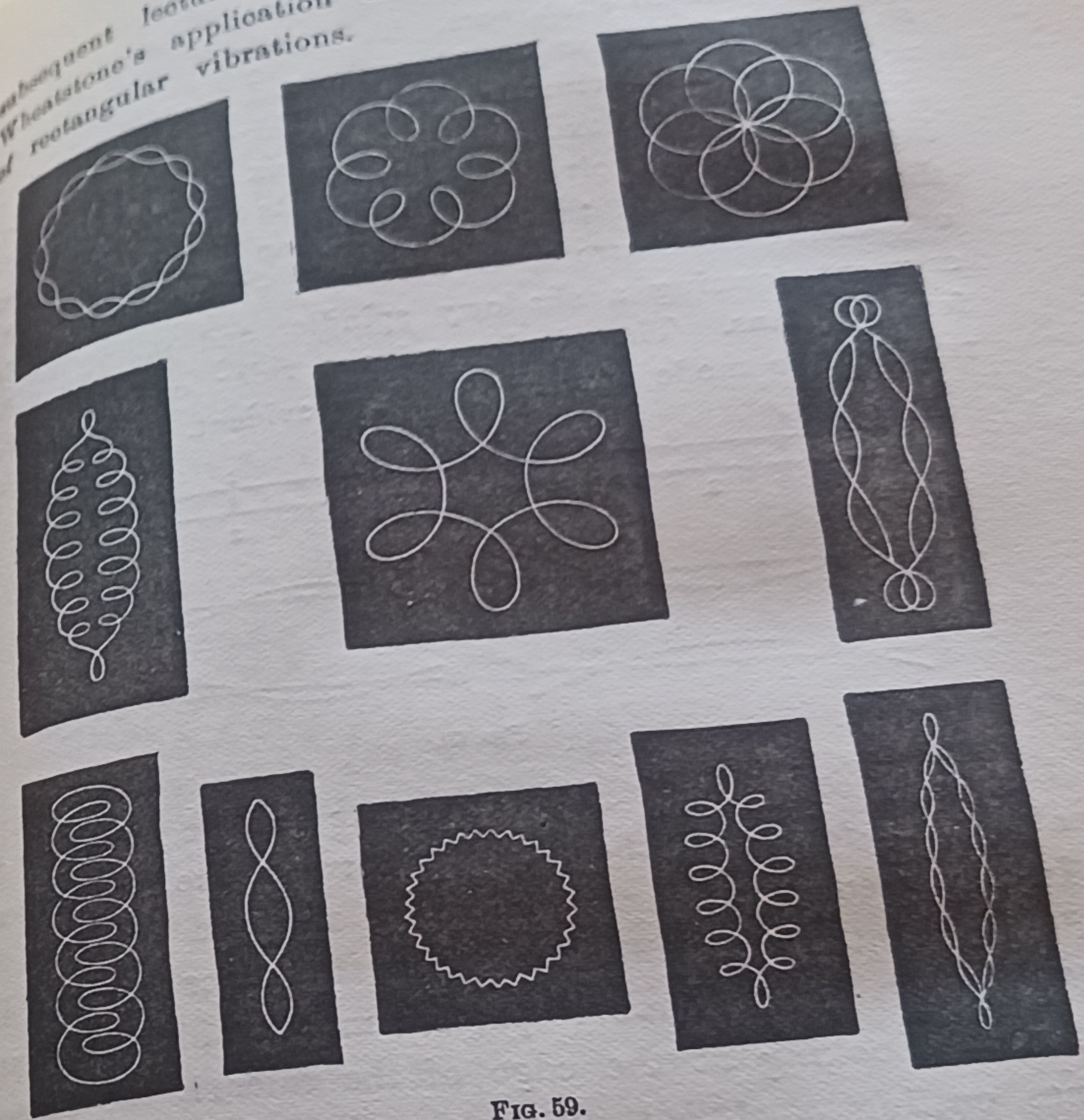


FIG. 59.

§ 4. Transverse Vibrations of a Rod free at Both Ends.  
 The Claque-bois and Glass Harmonica

From a rod or bar fixed at one end, we will now pass to a rod or bar free at both ends; for such an arrangement



172  
SOUND  
we shall become acquainted with  
of his method to the study

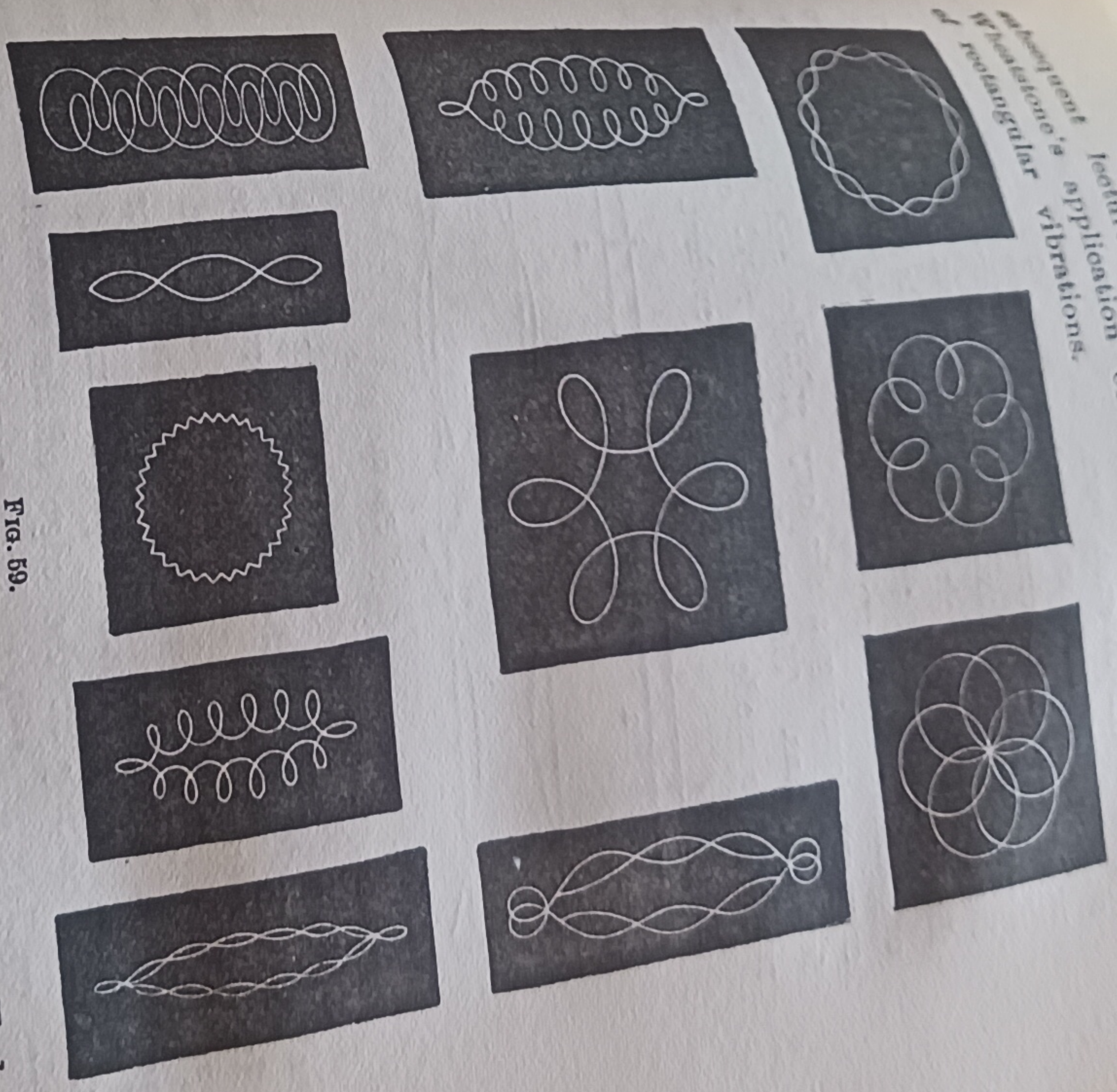
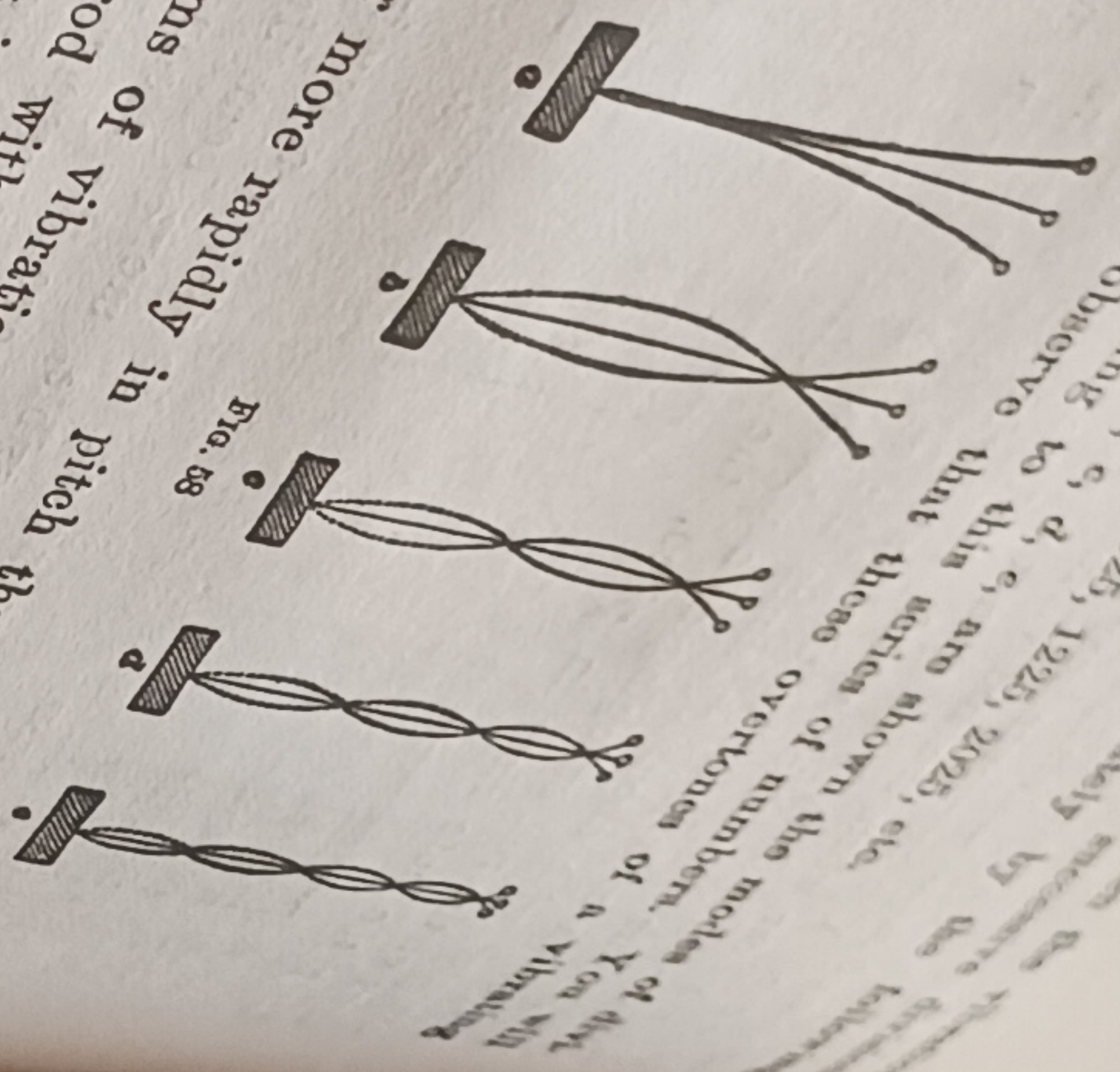


FIG. 59.

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In Fig. 58, a, b, c, d, e, are shown the modes of vibration corresponding to this and to its successive harmonics; 26, 225, 625, 1225, 2025, etc.



rod rise far more rapidly in pitch than the harmonics of a string. Other forms of vibration may be obtained by smartly striking the rod with the finger near its fixed end. In fact, an almost infinite variety of luminous scrolls can be thus produced, the beauty of which may be inferred from the subjoined figures (see next page) first obtained from C. Wheatstone. They may be produced by illuminating the bead with sunlight, or with the light of a lamp or candle. The scrolls, moreover, may be doubled by employing two candles instead of one. Two spots of light then appear, each of which describes its own luminous line when the knitting-needle is set in vibration.



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TELEPHONE

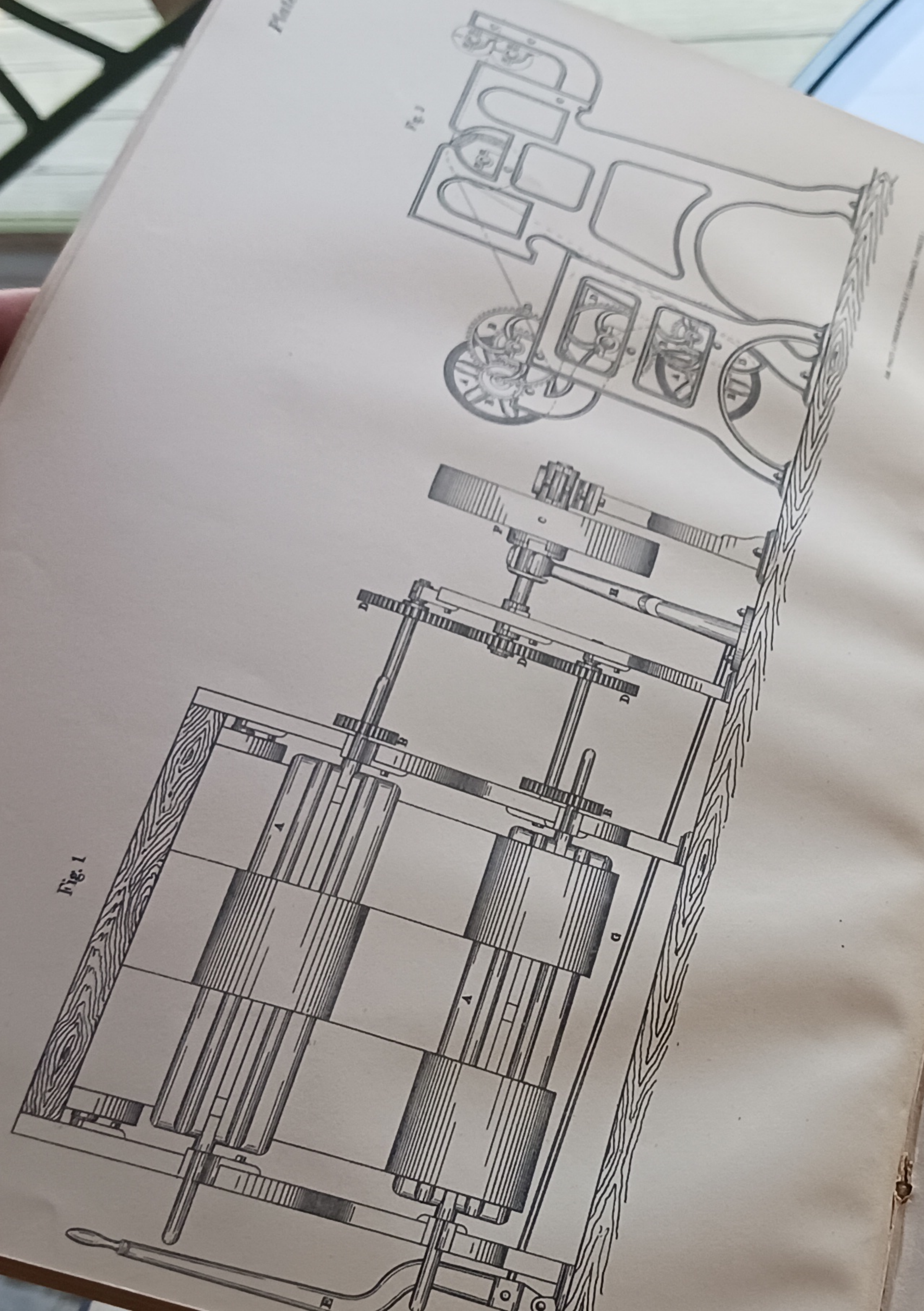
VOLUME II



HERBERT  
AND  
PROCTER

VOL. II





# PLATE No. 19,

Represents a Winder, for winding paper as it comes from the reels. Fig. 1 is front elevation, and Fig. 2, end elevation. A, A are reels, upon which the paper is wound, connected to driving arrangement by gears B, B, as shown in Figs. 1 and 2, thence to pulley C, by means of gears D, D, D, all being put in motion by lever E, from front side of machine, connected to clutch F, by rod and fork H. The sheet is made into three webs by the slitters I, I, Fig. 2, then wound upon reels, as shown.

This arrangement for winder has been found very convenient where winding is done a large portion of the time. It can be attached to almost any cutter, and removed when not required.



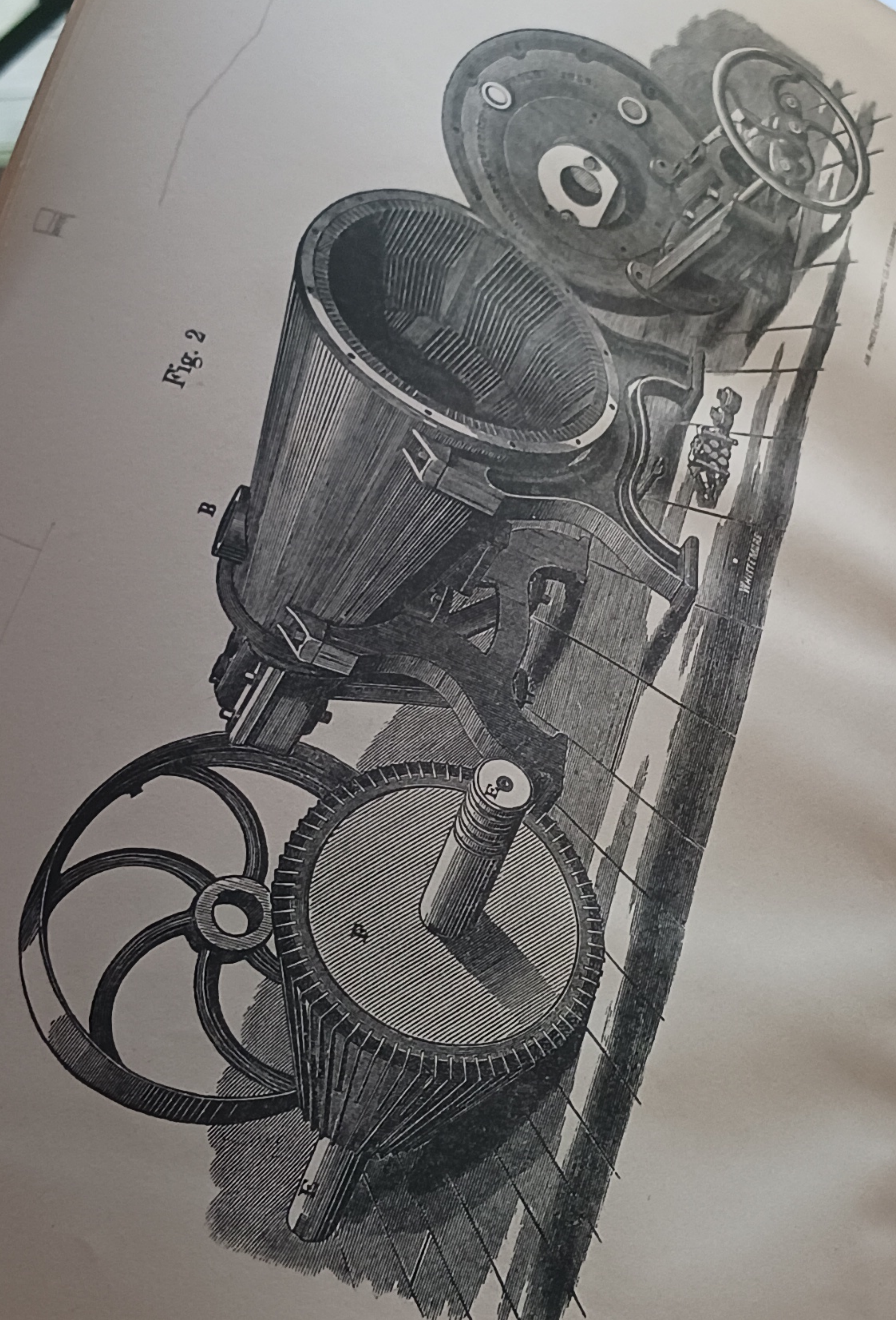


Fig. 2

# PLATE NOS. 11 and 13,

Represent a Jordan & Eustice Patent Beating Engine, used for the purpose of clearing paper stock after it has been three-quarters beaten. Fig. 1 represents the machine when together, ready for use. Fig. 2 represents the machine when taken apart. A, Fig. 1, represents a stuff box, or receptacle for the stuff when pumped from chest or reservoir. The stuff enters at the point B, as indicated on Fig. 2, and is discharged at the point C, Fig. 1. We show pulley D, for driving, attached to shaft E, E, Figs. 1 and 2, upon which a cast iron cone F, is attached, filled with knives, as shown. We also show the knives in shell, Fig. 2.

The machine having been put together as seen in Fig. 1, and having been adjusted properly, the internal cone F, Fig. 2, is forced laterally by means of the hand wheel and screw G, Fig. 1.

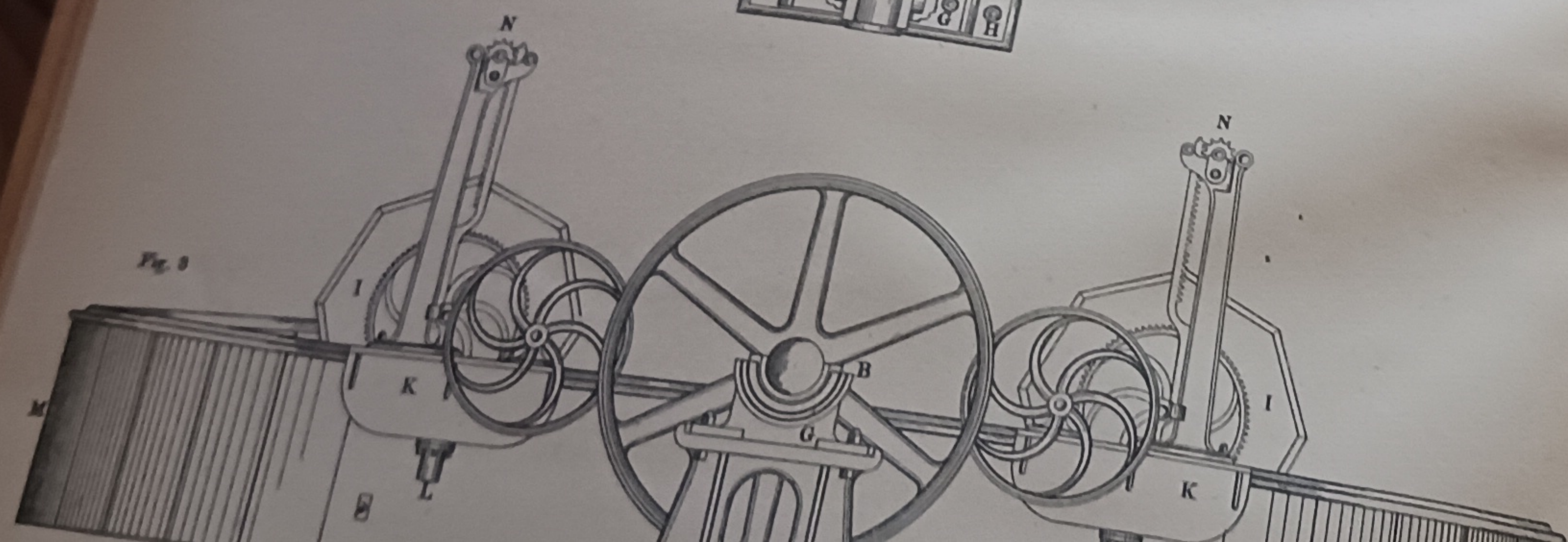
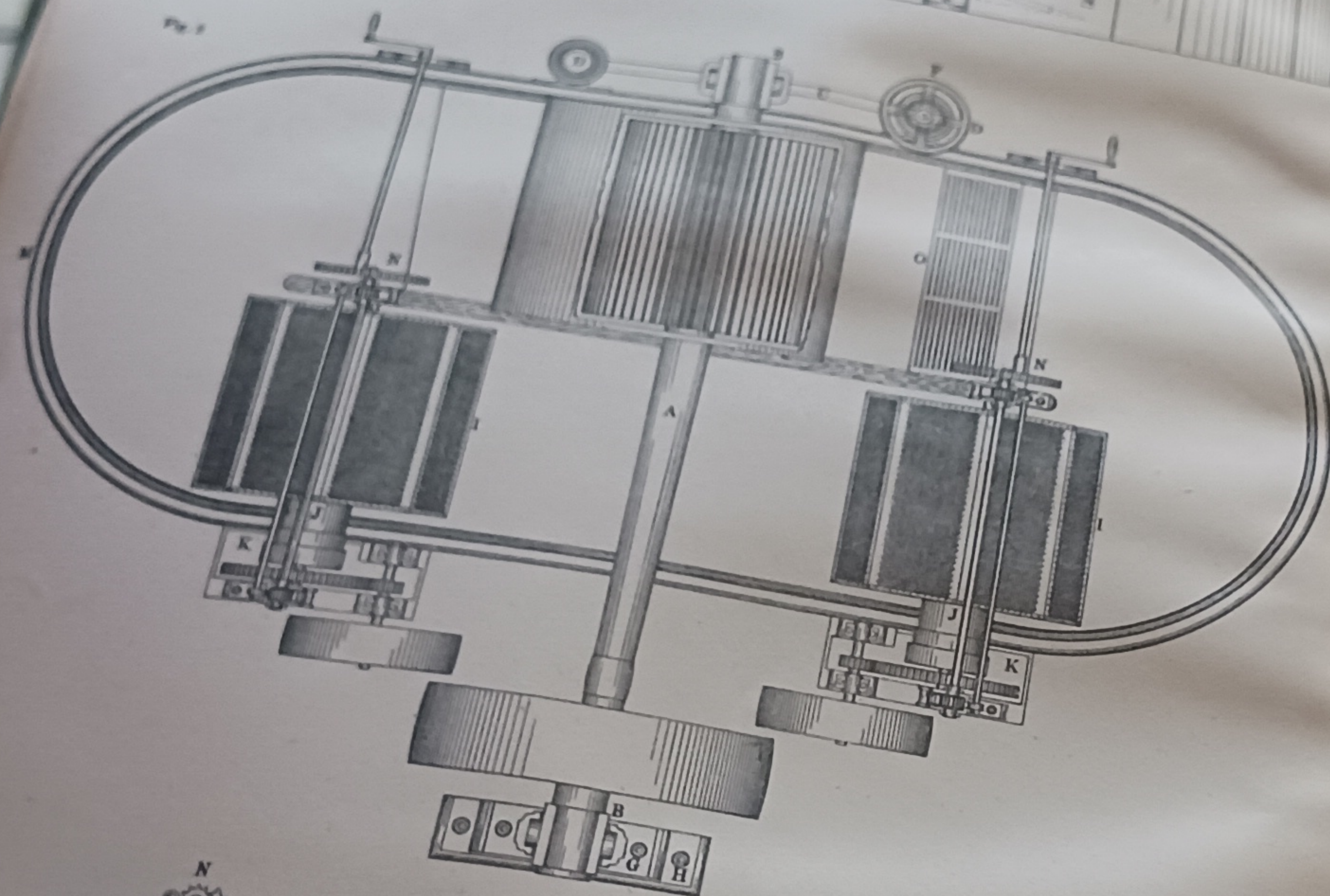
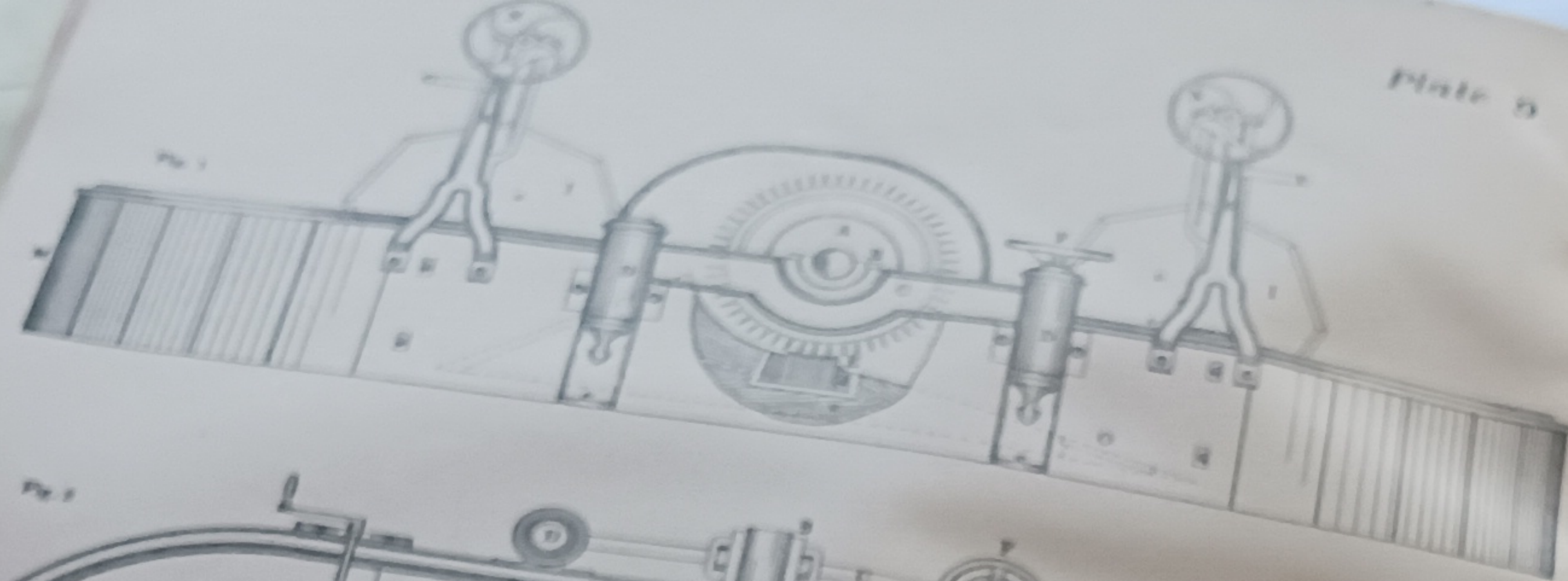
The operation of this machine is so well liked by all who see them running, that nearly all mills upon book and news papers are adopting them as the best machines for clearing the stock, as nothing passes through this machine without being brushed.

We can recommend this machine above all others, to parties wishing a clear, uniform pulp, and perfect paper.









## PLATE No. 9.

Represents a Rag Engine. Fig. 1 represents front side elevation, Fig. 2 represents ground plan, and Fig. 3, back side elevation. A, Figs. 1 and 2, and 3, at either end. C, C, and D, D, represent lighter and posts, for the purpose of raising and lowering the knives or roll on to the bed plate E, as shown in Fig. 1. This is accomplished by means of the hand wheel F, Figs. 1 and 2, which operates as a nut working upon a screw, which raises or lowers end of lighter, also the roll. The back end of spindle is supported on pillow blocks G, washers for removing the water from the engine and stuff while it is in motion. These consist of octagonal shaped cylinders, the faces of which are covered with wire cloth, seen in Fig. 2, and made to revolve by means of pulleys and gears represented in Fig. 2. While revolving, the water passes through the wire center and end of the cylinder being such that the water is carried to the and discharged into the iron box K, which is bolted to the side of tub, thence through the outlet pipe L, Fig. 3.

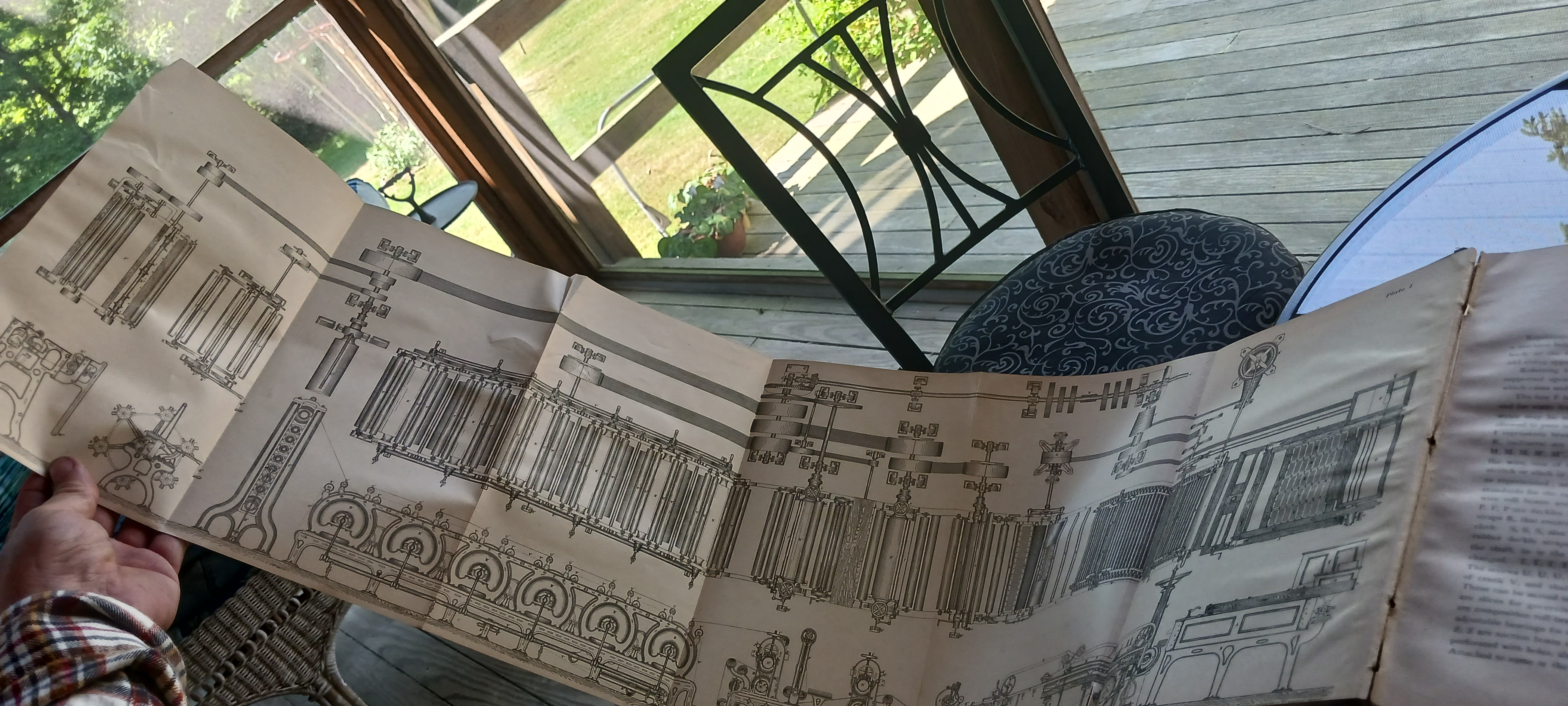
Thus, dirty rags or other stock to be washed are placed in the tub M, Figs. 1, 2, and 3 (which is made of wood or iron as desired). Clean water is supplied, as represented in Fig. 1, the washers are lowered into place by means of the rack and gears N, N, Figs. 1, 2, and 3, when the dirty water is at once discharged as described above. When the washers are not required, they may be raised out of the stuff entirely by the same process, racks and gear as described.

O, Figs. 1 and 2, represents a screen made of iron, for the purpose of collecting sand or other hard substances that would ordinarily settle at the bottom of the stuff.











TELEPHONY  
VOLUME II



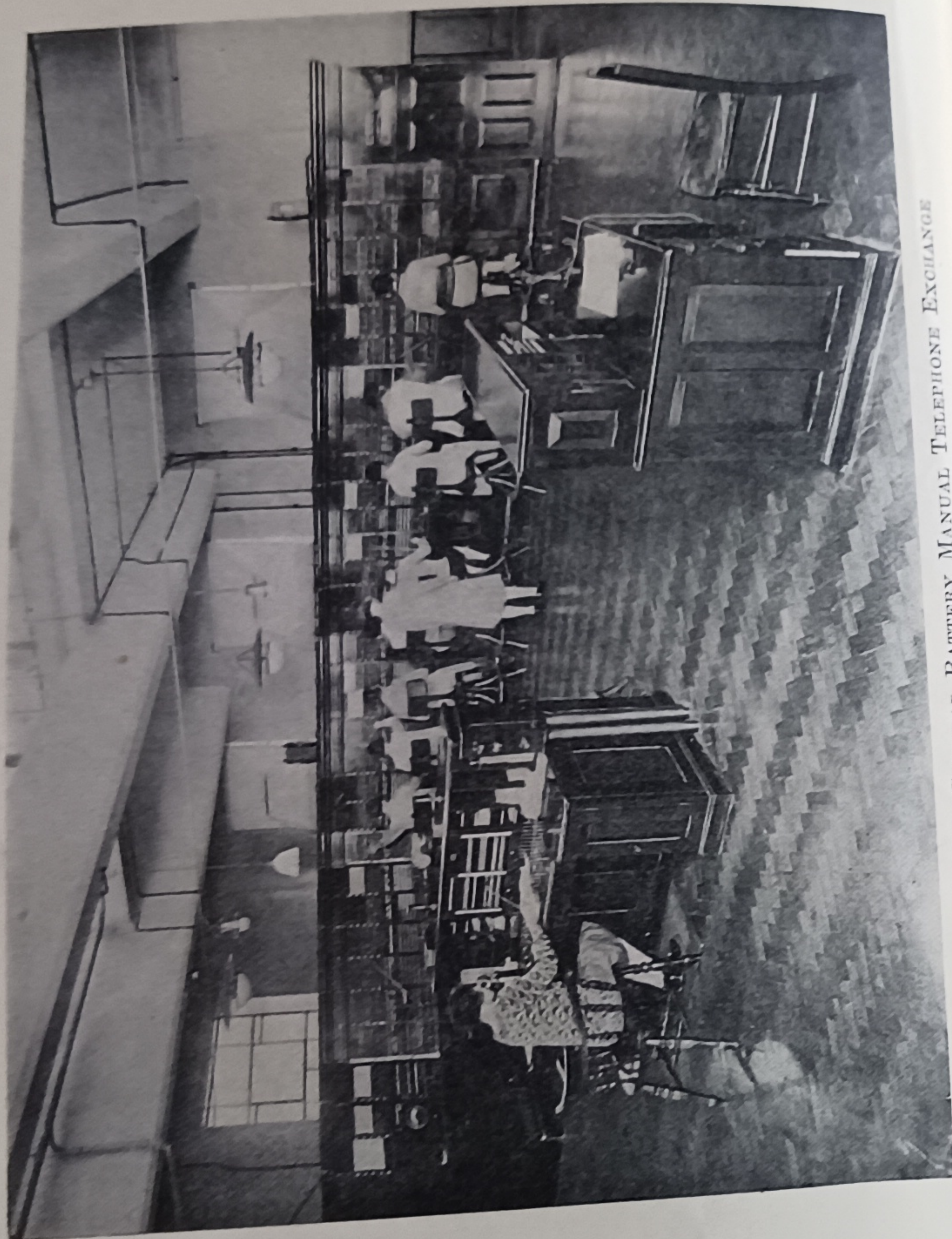
HERBERT  
AND PROCTER

TELEPHONY  
VOLUME I



HERBERT  
AND PROCTER





A MODERN CENTRAL BATTERY MANUAL TELEPHONE EXCHANGE

Frontispiece

# TELEPHONY

A DETAILED EXPOSITION OF THE  
TELEPHONE SYSTEM OF THE BRITISH  
POST OFFICE

BY

T. E. HERBERT, M.I.E.E.

SUPERINTENDING ENGINEER, POST OFFICE ENGINEERING DEPARTMENT

AND

W. S. PROCTER, A.M.I.E.E.

ENGINEER IN-CHIEF'S OFFICE, POST OFFICE ENGINEERING DEPARTMENT  
ASSISTANT EDITOR, "POST OFFICE ELECTRICAL ENGINEERS' JOURNAL"

SECOND EDITION

VOLUME I

MANUAL SWITCHING SYSTEMS AND LINE PLANT

THE NEW ERA PUBLISHING CO., LTD.  
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It will be seen, then, that the instruments employed for the commercial transmission of sound may be divided into two broad classes, viz. those which generate a current as a result of the reception of sound waves, and those which modify the electrical characteristics of a circuit when they receive sound waves. The former type is much more efficient as regards the quality of the reproduced sound and when used in conjunction with an amplifier, as in certain transmitting arrangements employed in broadcasting studios, etc.,

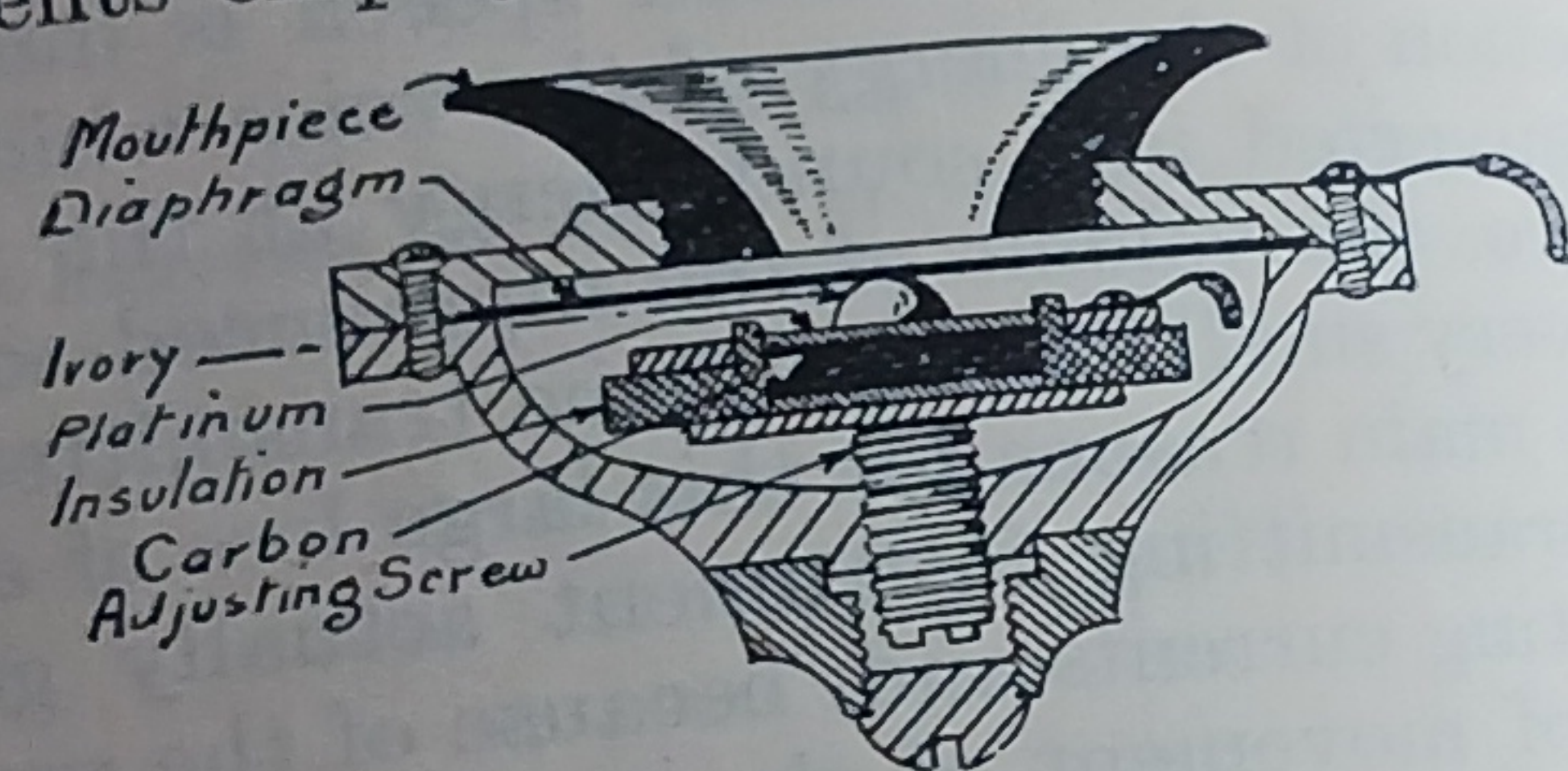


FIG. 112. EDISON TRANSMITTER

the difficulties encountered in the early days of telephony are overcome.

*Definition.* In telephony, a transmitter is defined as "an electro-mechanical device designed to convert sound waves or vibrations into electrical waves or vibrations for transmission over a telephone or other circuit."<sup>1</sup>

In the Edison transmitter (Fig. 112), the circular ferrotype diaphragm rests upon an ivory button attached to the upper plate of the pair between which the disc of lamp-black (carbon) is contained. A table provided with a screw serves to carry the arrangement of the steady mechanical

communicated to the upper platinum plate, which, by varying the pressure on the carbon disc about the steady value, varies the resistance of the instrument between the two platinum plates forming the terminals of the transmitter. It is now well recognized that the action depends, not upon the reduction in the resistance of the carbon due to compression, but upon the variation in the resistance of the area of contact between the carbon plates and the platinum.

In May, 1878, Professor Hughes read his historic

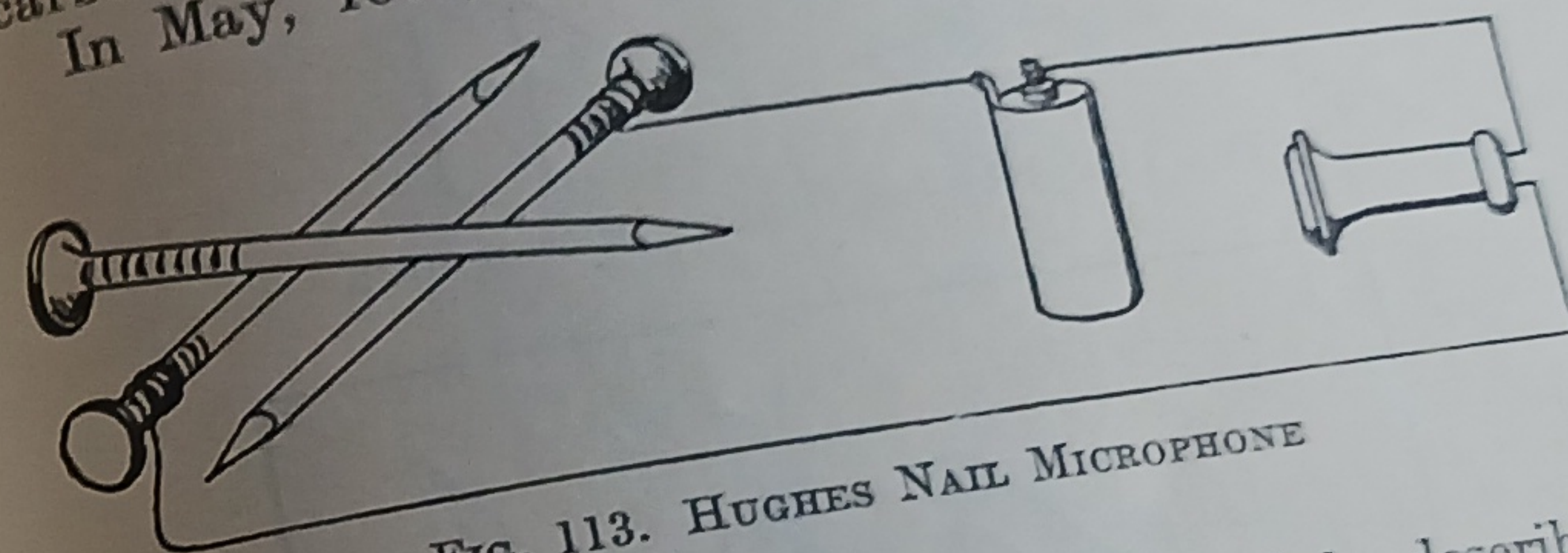


FIG. 113. HUGHES NAIL MICROPHONE

paper before the Royal Society, in which he described his discovery that any system of loose contacts will form a telephone transmitter. Three iron nails joined up in circuit with a battery and a receiver, as shown in Fig. 113, are capable of transmitting speech. To all such instruments he gave the generic title of "microphone," owing to his belief that the original sounds were amplified.

*Definition.* In telephony a microphone is defined as "a transmitter designed to have its electrical resistance directly and materially altered by slight differences in mechanical pressure such as are caused by sound waves or vibrations."<sup>2</sup>

The fundamental principle of the action of a microphone lies in the fact that loose contacts vary in resistance when the members are thrown into vibration by sound waves. After many experiments, Professor



magnetic field, and the highest value of the E.M.F. will therefore be generated at the moment when the plane of the coil lies along the magnetic field. For, if the motion of any conductor be considered, it is cutting the lines at the greatest rate at the instant when it is opposite to the middle of the N. pole, its motion at that instant being practically parallel to the pole. When it has moved through  $45^\circ$ , it is moving at this angle to the field and the rate of cutting is less; at the

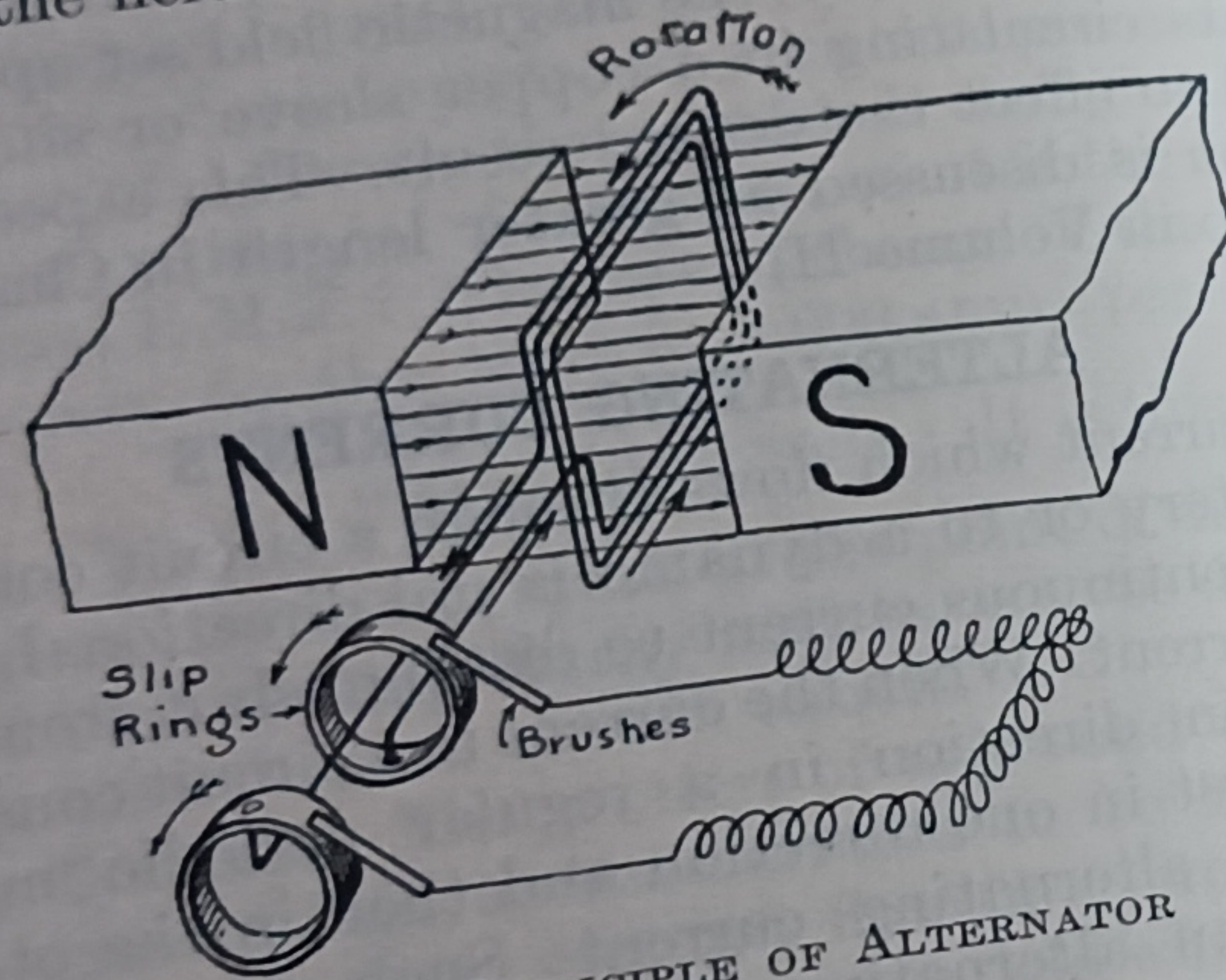


FIG. 22. PRINCIPLE OF ALTERNATOR

top of the field, the conductor is moving along the lines, and the E.M.F. generated at this instant is nil. As the conductor passes over the top, it commences to cut the field in the opposite direction, and the E.M.F. in the reverse direction begins and grows in strength until, when the conductor is opposite to the centre of the S. pole, it reaches a maximum. From this point it moves until at the bottom of the field it is again zero. The number of lines

exemplified by the "generator" which is so extensively used in telephony. In reality, it is the Siemens magneto-electric machine of 1857, made to a small scale and minus the commutator.

The generator usually consists of three permanent horseshoe magnets whose poles of like sign are united by two hollowed soft iron pole pieces, between which

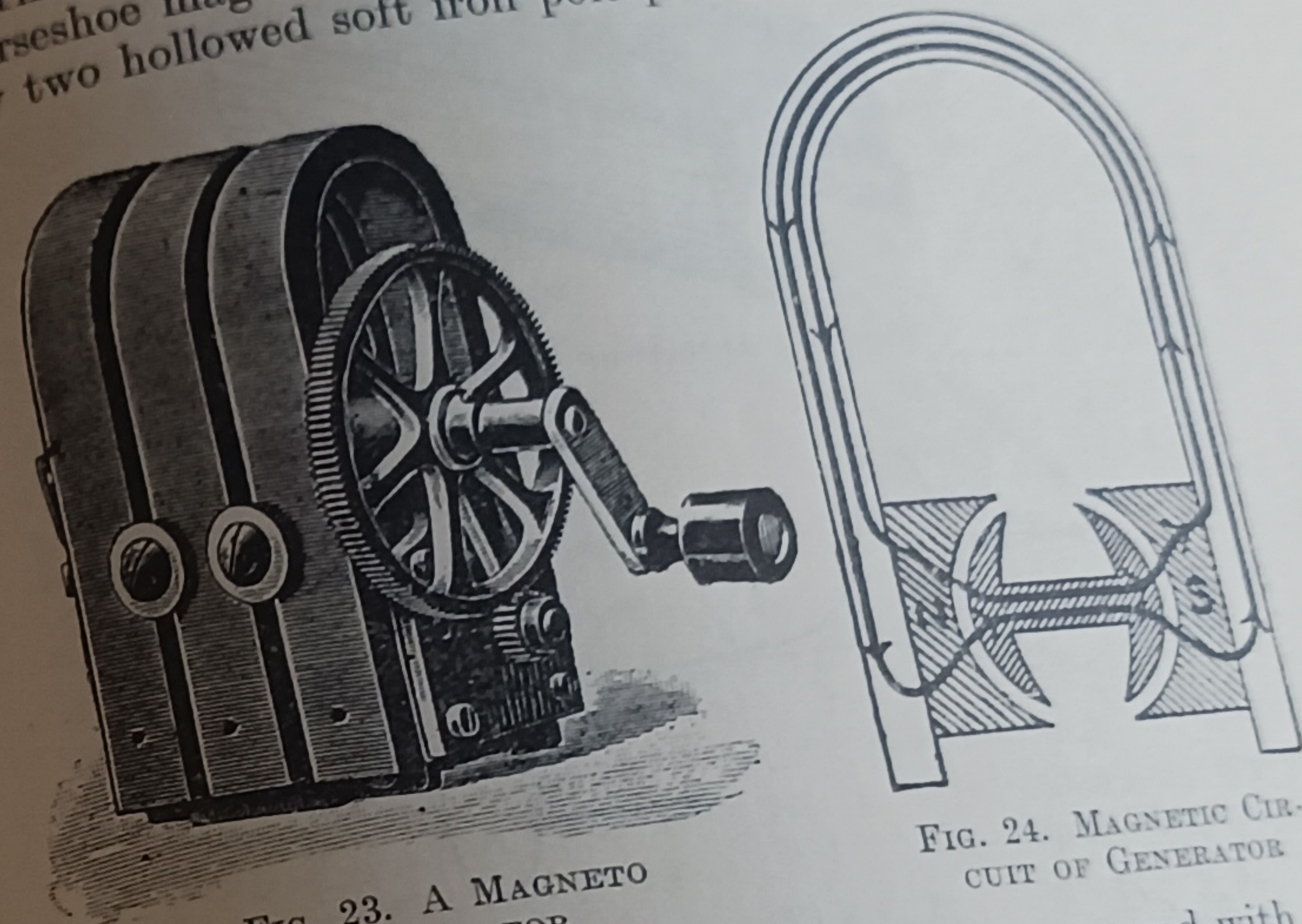


FIG. 23. A MAGNETO GENERATOR

FIG. 24. MAGNETIC CIRCUIT OF GENERATOR

is placed a revolving armature of soft iron wound with a suitable number of turns of fine, silk-covered copper wire. The instrument as a whole is illustrated in Fig. 23, and constructional sketches are given in Figs. 24 and 25. The armature is of the well-known H-form, and the coil is wound on the central web. When the armature occupies the position shown in Fig. 24, the lines of force pass through the central web in the general direction shown by the two heavy lines. When the position of the armature with respect to the magnet is changed, the position of the lines with respect to the armature is altered, thereby generating an E.M.F.













**WARNING**  
DO NOT LOCK THE COVER AND OPERATE THE MOTOR  
WITH THE COVER CLOSED OR THE MOTOR COULD BE  
DAMAGED OR PERSONAL INJURY COULD OCCUR. THE USER  
SHOULD ALWAYS USE THE COVER TO PROTECT THE  
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FROM INJURY OR DAMAGE.



























